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Work—a Source of Contentment

By J. J. Jahobart

WORK, according to Webster, is physical or intellectual effort directed to accomplish an objective. The mechanical definition of the word is, the overcoming of resistance continually occurring along a line of motion.

Work, according to some fellows, is nothing more nor less than slavery. They consider it a contemptible law of humanity, imposed upon a multitude of abject fellow-beings by a certain few who revel in their ill-gotten wealth, supposedly accumulated through the unappreciated efforts of their less fortunate fellows. And so it is, that far too many of us have a distorted, warped conception of the real reason for work.

But why look at work with the wisted idea that you are being imposed upon, if you are by the nature of things compelled to earn your daily sustenance by honest labor? Surely, it is no dishonor to have to do one's share of the work required to make this old world a decent place to live in. And if you don't find it a reasonable place to live in, it is no one's fault but your own. It is your fault to the extent that you listen to the wrong side of the issue.

You cannot add unlike numbers, such as six marbles and six oranges, and get twelve peaches out of it, but you can add six industrious workers and six indifferent drifters and get a dozen poor workers, so far as total results are concerned. Why? Because it is invariably an easy matter for the indifferent fellow to sow the seeds of discontent and doubt in the mind of his fellow-workmen. His slogan is "GET all you can with the least effort," and this same fellow makes more noise than all the rest of the crew, when the salary increases and promotion slips pass him up.

Work is not alone the safety valve for accumulated energy. It should be a source of pleasure and contentment Whether the job is holding you or whether you are holding the job depends upon your state of mind, and the morale of a working force, an army or a baseball team depends upon its state of mind. The pity of it is that one casehardened shirker and kicker among the employees can do more to lower this standard than almost any other agency.

Did you ever go to work in the morning feeling like you owned the universe? Just running over with "pep"? Just when you get your day's work organized, some fellow comes along and spills his tale of misery, and after listening a few minutes, you begin to feel as though you would like to go home. You are lucky if this has not happened to you. But without doubt it has, therefore you know by experience how dangerously contagious such misdirected suggestion is to the man who really wants to GET AHEAD, and knows the value of work.

Low Temperature Distillation of Coal

By C. M. GARLAND
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Various methods of distilling coal at temperatures averaging 900 deg. F. Coke produced is a clean, smokeless fuel suitable for domestic and small power use. Byproducts recovered per ton of bituminous coal are 20 to 30 gal. of tar valued at 10c. per gal. and 12 lb. of ammonium sulphate worth 3c. per lb. For power plants with constant load burning over 50 tons of coal per day, a combination of the low-temperature process with a byproduct gas producer to recover a much greater percentage of ammonium sulphate offers remarkable advantages for improving economy. The byproducts pay for the coal, the overhead and operating expense, and the gas, containing about 70 per cent. of the heat in the coal and burning at higher efficiency, is available for fuel under the boilers or for direct use in gas engines.

LOW-TEMPERATURE distillation of coal is carried out in closed retorts at temperatures ranging from 700 to 1200 deg. F., as opposed to high-temperature distillation, common in coal gas and byproduct coke-oven practice, where the coking temperatures vary between 1800 and 2500 deg. F. The effect of this difference in coking temperature is very marked on the coke produced and also on the byproducts. The high-temperature process produces a dense, hard coke that is highly adapted to blast-furnace and foundry practice where forced blasts are used to produce high temperatures. The high ignition point and the high draft required to maintain a fuel bed have tended to render the use of this fuel somewhat unpopular as a domestic product.

While the low-temperature coke is a much softer product, it has sufficient mechanical strength for all practical purposes, possesses a low ignition point, permits the maintenance of a fuel bed under low draft and burns without smoke notwithstanding the fact that it is commonly sent out with from 3 to 18 per cent. volatile remaining in it. The mechanical strength of this material is not sufficient for it to sustain a furnace burden, and for this reason it is not suited to metallurgical operations as a rule.

Between the byproduct from the high- and low-temperature distillations the difference is even more marked than in the respective cokes. From the high-temperature distillation, as carried out in coal-gas and byproduct coke-oven plants, from 8 to 15 gal. of tar per ton of coal is produced as compared with 20 to 30 gal. per ton from the low-temperature process. The high-temperature tar is a black, gummy mass having a specific gravity of about 1.2 and containing from 60 to 80 per cent. pitch and free carbon. This tar sells at from 2 to 3½c. per gal. The low-temperature tar contains from 30 to 40 per cent. pitch and free carbon, a large percentage of tar acids suitable for wood preservation, etc., together with low-boiling distillates suitable for motor fuel. The specific gravity is about 1.07, the color dark brown and the consistency about the same as a heavy machine oil. Investigations indicate that this tar at the present time has a value close to 10c. per gal. in the crude state.

In the low-temperature process the temperatures are too low for a large yield of ammonium sulphate. Twelve pounds per ton of coal as compared with 20 to 35 lb. for the high-temperature process is representative. The volume of gas produced is also small and will vary from 1000 to 4000 cu.ft. per ton of coal as compared with from 10,000 to 12,000 cu.ft. for high-temperature distillation. This low-temperature gas has a caloric value of from 750 to 1000 B.t.u. per cubic foot as compared with from 500 to 600 B.t.u. for the high-temperature gas.

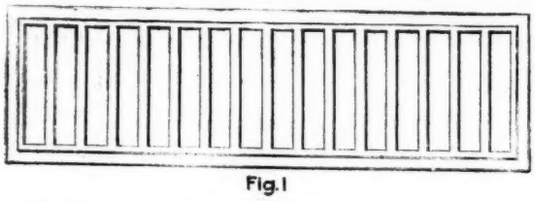


Fig. 1

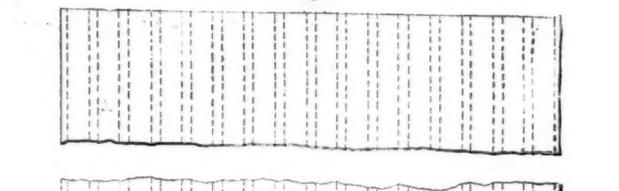


Fig. 2

FIG. 1. PLAN VIEW OF TRAER RETORT. FIG. 2. SIDE ELEVATION OF TRAER RETORT

On the byproducts from coal the general effects of low-temperature distillation have been known for a great many years. The value of the process as a means for the production of a clean, smokeless fuel possessing a low ignition point together with the recognition of the possibilities in the use of the byproducts has been growing in the minds of investigators along these lines for the last 15 years. The English have been most active, and several schemes for carrying out this process have been brought out and some have reached the commercial stage.

In this country Parr, at the University of Illinois, began in 1906 some experiments which have been continued up to the present time. Also there have been several schemes for the carrying out of the low-temperature process on a commercial scale suggested by different investigators in this country. The most promising of these schemes at the present time are the ones brought out by G. W. Traer, of the Universal Coal Products Co.; "Carbocoal," as brought out by Charles H. Smith and financed by Blair & Co., of New York; the G. & L. process, brought out by Greene & Laucks, of Denver; and the process brought out by Bostaph.

In carrying out the low-temperature process, one of two general schemes may be used—either the coal may be crushed and then charged into forms or retorts in which it is coked, or the coal may be coked during its passage through some form of retort in which a screw or propeller is used to push the coal forward as it undergoes coking. In the latter scheme the finished byproduct must be briquetted if it is used for domestic purposes. In the former the coke comes out in a molded form and must be crushed for market.

In the processes of Traer and Bostaph the coal is coked in cast-iron forms. In the Traer process, which has developed under the writer's supervision, the coal is charged into a vertical form which is divided by partitions to produce rectangular slabs of coke about 4 x 12 in. in cross-section by about 6 ft. in length. Sixteen of these slabs are produced in one form. The forms are provided with drop bottoms and are mounted on trucks. The coal is coked in these forms by being slowly moved through an oven which is heated by side flues.

Fig. 1 shows a plan view of the Traer retort, Fig. 2 a side elevation and Fig. 3 a side elevation in part section of the oven through which the retorts are pushed. These ovens are approximately 100 ft. long and are equipped at each end with two hydraulically operated doors. These doors form a lock through which the retorts are pushed to and from the ovens without the escape of gas.

These retorts are handled with a combination "puller and pusher," electrically operated, which runs on a track, one at each end of the group of ovens. They push the freshly charged retorts into the oven at one end and pull them out at the opposite end. The retorts are filled from an overhead coal bin and are charged at one end of the oven, discharged at the opposite end, recharged and sent through the adjacent oven. The ovens are therefore operated in pairs. An overhead coal bin extends across each end of the ovens, also a conveyor for receiving the coke extends across each end of the ovens onto which the coke from the retorts is dropped. The coke is quenched while on these conveyors and is transferred to a belt conveyor which delivers it to the crushing and screening plant. A photograph of a piece of coke produced is shown in the headpiece to this article.

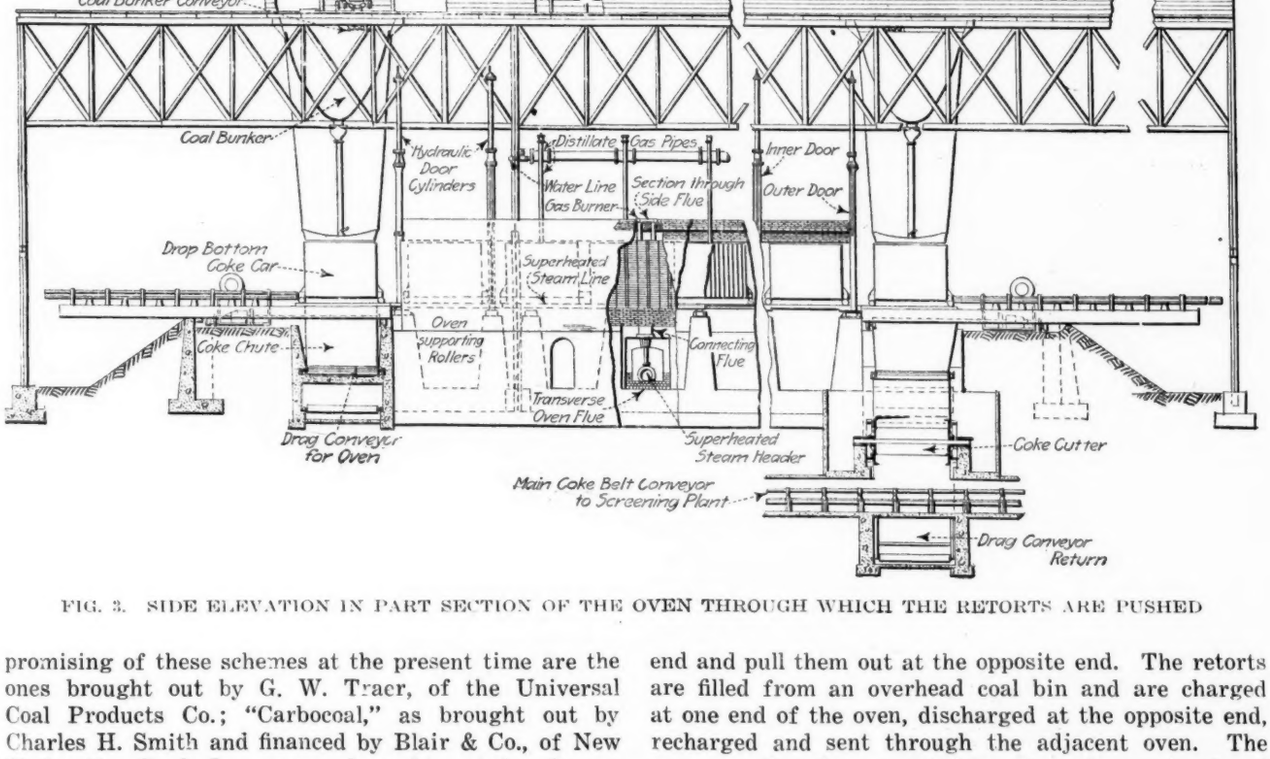


FIG. 3. SIDE ELEVATION IN PART SECTION OF THE OVEN THROUGH WHICH THE RETORTS ARE PUSHED

In the Bostaph arrangement the coal also is coked in the form of slabs, but these slabs form segments of a cylindrical drum which is provided with a hollow core for drawing off the products of distillation. Fig. 4 is a cross-section of the Bostaph retort. The heat is supplied externally, and the products of distillation pass through perforations in the inner wall of the retort to the central core, the idea being that the products of distillation will never come into contact with a higher temperature than that from which they

are distilled. This prevents the breaking up of the products, which occurs whenever they are brought into contact with surfaces of a higher temperature. In the Traer process this is accomplished by drawing the gases off the tops of the retorts immediately after they are generated.

In the low-temperature process, where the coking is carried on in fixed retorts of the Traer and Bostaph types, the coal must be coked in thin layers to produce a uniform product. This means that the coal and coke must be handled in small quantities. The problem in the design of such plants is therefore to keep down the cost of handling. It is the opinion of the writer that the Traer process has a lower operating cost per ton of coal handled than any of the plans proposed up to the present time.

Keeping Down the Costs

In the Smith process the coking is carried out in two stages. The coal to be coked is first forced through a retort by means of a screw or propeller. The retort is maintained at a temperature of about 900 deg. F. The coke discharged from this retort is in a finely divided conditon, not well adapted for domestic distribution. It contains a comparatively large percentage of volatile and, after it leaves the first retort, is mixed with a certain percentage of pitch and then briquetted. The briquets are subjected to a temperature in the neighborhood of 1800 deg. F., which cokes the pitch and drives off most of the volatile remaining in the coke from the first distillation.

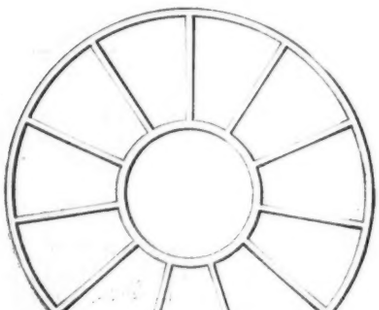


FIG. 4. CROSS-SECTION OF BOSTAPH RETORT

In the G. & L. process a vertical retort is used that contains propellers for forcing the coal through the retort. These propellers are mounted on a hollow shaft, and the products of distillation are drawn out through this shaft. In this process the coke produced is not as yet briquetted. Undoubtedly, briquetting will have to be resorted to in order to produce a satisfactory fuel for household use.

Advantages of Traer and Bostaph Processes

The Traer and Bostaph processes have an advantage in that the operating cost and the first cost of the plant are much lower than is possible with a plant employing the briquetting process. The coke produced from these processes, while it does not possess the mechanical strength of the briquetted product nor the density, is an excellent domestic fuel and can undoubtedly be burned with a much lower draft. The fuel produced by the Smith process is an excellent one and possesses the advantage just referred to, of greater mechanical strength, but must necessarily sell for a much higher price.

From all these processes the fuel produced is highly adapted for domestic use and for small power work. They are essentially processes for the manufacture of a clean, smokeless, domestic fuel, suitable for replacing anthracite, semi-anthracite and hard coke. The processes possess possibilities, however, for use in connection with large power work and the writer is of the opinion that ultimitely a large portion of the coal used in the generation of power will be subjected to some such process for the removal of the tar and ammonia.

From the low-temperature process the tar yields a large quantity of oil suitable for motor fuel. It is also possible to crack this tar and produce a much larger quantity of motor fuel. From our knowledge of the cracking process at the present time, it would not seem impossible to obtain from 15 to 20 gal. of motor spirit per ton of bituminous coal gasified. In addition to this, by the low-temperature process from 12 to 20 lb. of ammonium sulphate may be obtained.

Fuel Oil From Low Temperature Process

There is, however, a still greater development which must ultimately result from this line of investigation, and that is a combination of this low-temperature process with the byproduct recovery gas producer for use in the generation of power. In the byproduct gas producer, as exemplified by Mond, the coal is gasified in a special type of producer in which a large quantity of superheated steam is mixed with the blast. The result is that a large amount of ammonia is formed by the superheated steam from the nitrogen contained in the coal. This ammonia is recovered by scrubbing the gas with dilute sulphuric acid in the form of ammonium sulphate. By the Mond process from 50 to 110 lb. of ammonium sulphate may be recovered per ton of coal, depending upon the percentage of nitrogen in the coal. Ordinarily, this ammonium sulphate has a value of about $60 per ton. Under present prices the value is close to $90 a ton, or about 4½c. per lb. It may be safely stated that for average conditions ammonium sulphate will have a net value of around 3c. a lb., so that the byproduct of ammonium sulphate will have a value of from $1.50 to $3.30 per ton of coal gasified.

The Mond Process in Europe

In Europe the Mond process has been used with a fair amount of success simply recovering the ammonium sulphate. The tar recovery from this process has been of little or no value, principally for the reason that the tar consists of from 75 to 85 per cent. of free carbon and pitch. By combining the Mond process with some modification of the low-temperature process, from 20 to 30 gal. of tar can be obtained per ton of coal having a value in a crude state of around 10c. per gal., or a value of from $2 to $3 per ton of coal gasified.

By the combination of these two processes byproducts may be obtained having a total value in the crude state of from $3.50 to $6.50 per ton of coal gasified. Undoubtedly, herein lies one of the largest possibilities in the power field. There are many large concerns that have spent hundreds of thousands of dollars trying to decrease the coal bill 5, 10 or 15 per cent. Binary vapor engines, high-compression internal-combustion engines and many other schemes have been tried in an attempt to reduce the cost of power. By the combination of the low-temperature distillation process with the Mond process the coal bill under proper conditions can be eliminated entirely.

Installations of this character are, however, only adapted to plants using 50 tons or more of coal per 24 hours. The operation also must be continuous 24 hours

per day and preferably 360 days per annum. The gases from the byproduct producers can be used for the generation of steam under boilers and this steam used in turbines for the generation of power, or they may be used direct in internal-combustion engines. Plants of this type also are highly adapted for use in steel mills, glass works and the ceramic industries for supplying a clean, cold gas that can be piped in small mains practically any distance up to 25 or 30 miles. For steel mills where coke is not required, this type of plant offers much greater possibilities than the byproduct coke oven.

A plant using as much as 50 tons of coal per day with an ammonium-sulphate recovery of 85 lb. per ton of coal, will generate power and just about eliminate the coal bill. In a larger-sized plant the returns from the byproducts will eliminate not only the coal bill, but also the cost of operation, including the fixed charges on the investment. With a still larger plant the operating costs can be eliminated and there may be a small surplus after the disposal of the byproducts.

Continuous Operation Necessary

In a plant of this character, however, the operation must be to all intents and purposes continuous, and the load factor should not be under 75 per cent. if the byproduct installation is designed to take care of the total power or gas output.

The natural question arises as to why plants of this character have not already come into use in this country to some considerable extent. The answer is that a number of reasons have delayed the development of this type of plant. In the first place the early attempts to use American coals in the Mond producer have not met with a very high degree of success. This has been due to insufficient knowledge of American fuels and their proper operation in byproduct gas producers. In addition to this the byproduct plant takes much space, requires the services of chemists, is costly to install and requires considerable labor in its operation.

The byproduct producer alone, which recovers only ammonium sulphate, did not promise sufficient to warrant the manufacturers, under ordinary conditions, resorting to this large outlay and embarking in a new business, in order to reduce the fuel bill. With the development of a low-temperature distillation process the combination of this process with the byproduct gas producer more than doubles the value of the byproduct, which unquestionably will now make the installation of plants of this character a more promising undertaking.

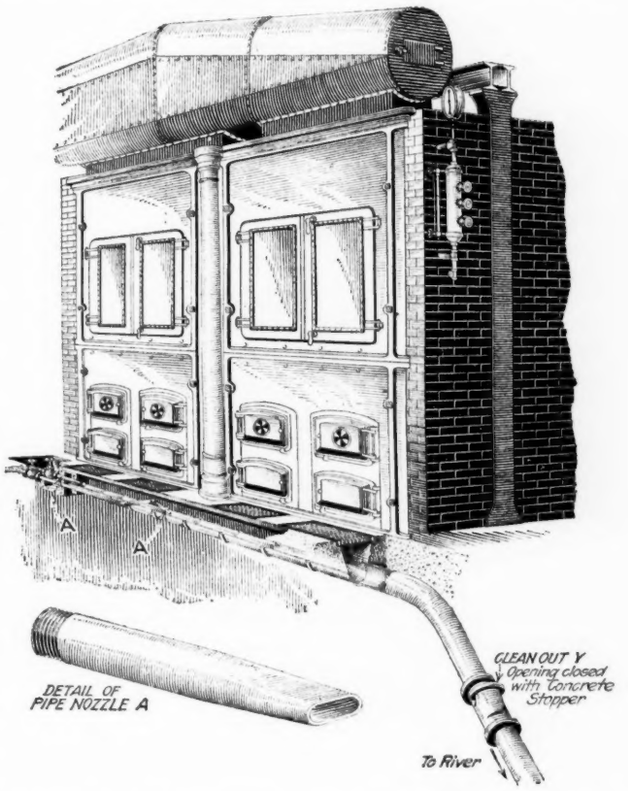
Ash-Sluicing System*

The illustration shows an arrangement for disposing of the ashes in a small electric-lighting plant. The installation consists of two 72-in. x 18-ft. return-tubular boilers that have two fire-doors each and are hand-fired with the usual run of small coal. The ash content of the coal varies from 15 per cent. to 25 per cent., and naturally there is a fairly large quantity of ash.

Previous to the installation of this equipment the ash was handled by means of wheelbarrows, entailing considerable expense. The arrangement illustrated consists merely of a sluicing trough of concrete across the front of the boilers, the bottom of the trough being lined with semicircular vitrified-tile pipe. A water jet is placed in front of each boiler in the position shown, and is fitted with the necessary operating valve.

The ash duct is covered by small concrete slabs, except in front of each ashpit door, where a cast-iron grating is located. The ashes are sluiced down by means of the water jet, and a 10-in. vitrified-tile pipe is connected to the end of the trough and carried away to the place where the ashes are to be deposited—in this case to the bank of a near-by river. Clean-out Y's are placed in the line of tile pipes to facilitate the removal of obstructions that may occur.

The trough is given a fall of one-half inch per foot, which is found in practice to be quite ample to carry away clinkers of any reasonable size. This slope could be varied from one-fourth inch per foot to three-fourths inch per foot, as desired. Quick-opening valves are desirable, although not absolutely necessary.



SLUICING ARRANGEMENT IN FRONT OF BOILER FOR ASH DISPOSAL

The cast-iron grating is provided with a sheet-steel cover that is held to the grating by means of two straps fitted to hinge pins cast into the grating, so that the cover may be lifed from either side or removed entirely when desired. In the case of hand-fired boilers it is desirable that the gratings be covered when the boilers are fired, to prevent the loss of coal due to spillage. When raking ashes from the ashpit, the cover would be lifted toward the fireman, so that the ashes could be raked on to the grating.

Any large clinkers that are pulled out of the ashpit have to be broken through the grating. This does away with pieces of clinker too large to be carried off by the sluicing trough. The ribs of the grating are made with the upper edges tapered in order to facilitate the breaking of the clinker.

*From data furnished by Frank Sawford, Taylor Engineering Company, Vancouver, B. C., Canada.

Physical Tests of Boiler-Steel Plates

By FREDERICK BIGGAM
Inspector of Steam Boilers, Provincial Government Office, Vancouver, B. C.

BRITISH Admiralty regulations stipulate that strips shall be cut from every plate proposed for boiler construction crosswise as well as lengthwise, 1½ in. wide, heated uniformly to a low cherry red and cooled in water of 82 deg. F. Such strips must stand bending in a press to a curve of which the inner radius is 1½ times the thickness of the steel tested.

The regulations of the British Board of Trade are the same as those of the Admiralty with the exception that strips are not required crosswise; that is, in the direction of the shorter dimension. Lloyds Registry and the Bureau Veritas have substantially the same requirements as the Board of Trade. So also have the Massachusetts Boiler Rules, except that the latter insist on one cold and one quenched specimen from every plate.

In Canada, where the rules of the British Columbia Boiler Act constitute the most rigid, and probably set the highest, standard of the Dominion in boiler construction, the requirements are practically the same as those of Lloyds or the Board of Trade, so that in regard to the fitness of material for boiler work, it may be stated with all propriety that the several inspection bureaus, representative of the best modern practice, unite in declaring the bending test a necessary and a searching probe in the hunt for reliable materials of construction.[1]

The Inspector Is Frequently Puzzled

The purpose of what follows here is not intended to disparage or belittle the valuable information that may accrue from properly conducted bending tests. It will be rather an endeavor to show that despite the persistence with which the time-honored bending tests recur in amended rules of inspection societies, these tests, to the wayfaring engineer, have not the finality that such persistence would seem to imply. Indeed, the surveyor—if he is of an engineering turn of mind—whose daily work engages him in witnessing bend tests, is often given "furiously to think" when brought face to face with certain phenomena in the behavior of steel under inspection. And he would be a bold man who would unhesitatingly scrap a plate because a random strip sheared from a corner showed the forbidden flaw. Equally daring would it be to classify as faultless material a sheet the best strip from which had bent gracefully over without a hair-line crack. As a matter of fact, the experienced inspector not infrequently finds himself puzzled to determine how far the interests of public safety may be stretched in order that a most whimsical material of construction may be harnessed for the public service.

Here is a record from actual experience. A number of $\frac{7}{16}$-in. boiler plates are laid out in order for testing. Every plate has its test-strip sheared or sawn to the regulation length, which is roughly seventeen times the thickness. These strips, after being marked for future identification, are broken from the plates. A little rounding of the edges prepares them for the bending cold test. Probably several of the sheets are of the same charge and have the same melt number stamped on. However, as the rules ignore any presumption of identical properties, every plate contributes its specimen strips.

The tests proceed and one unfortunate strip develops a pronounced flaw. It is identified as belonging to a particular plate with a certain melt number, and that plate's reputation is in jeopardy. The remaining strips are heated without mishap and then the results are adjudicated upon. It is found that the suspicious plate has the same melt number as two other plates, the test strips from which behaved quite normally. Here is food for thought, and the investigation of the apparently bad plate is carried a little farther. The failed specimen is pried apart and broken at the point of flexure. The two pieces, although now far too short for the orthodox bending tests, are given a chance to palliate the failings of the parent plate. One is bent in the same direction as the original strip and, as would be expected, it fails in the same manner as before. But the other is bent in the opposite direction to the original strip and it performs the feat without "turning a hair"! Finally, we go back to the now not so suspicious plate, and shear a properly dimensioned specimen from the same region as before. Care is taken to bend it in the direction opposite to that in which the first strip was bent, and again its behavior is above reproach. Now, is this particular plate unsuitable for boiler-construction purposes? And could this uncanny behavior be construed as satisfying the bending-test requirements of the inspection authorities?

It might be contended that this was only a coincidence, but the record is not one of an isolated case. Such phenomena have so frequently recurred in my personal experience that some other explanation than mere coincidence is needed. It should be clearly understood that the foregoing refers to the ordinary mill run of boiler steel of 55,000 to 65,000 lb. tensile strength, usually stamped at two places on every plate.

Boiler Plate Fibrous in Texture

The properties of steel form a highly technical subject that is outside the scope of this article. It may be said, however, that the material at the disposal of the boilermakers is to a certain extent fibrous in texture. This property may not inhere in the ingot, but is induced by the process of rolling from ingot to plate. At all events, the ordinary boiler plate is fibrous, as is quite plain when a failed test specimen is examined under a magnifying glass. It is also generally conceded that the grain or fiber is induced in the direction of rolling, which direction is the longer dimension of the plate as delivered to the boiler shop.

The experience of boiler-inspection bureaus seems to connect very decidedly the longer dimension of a plate with the run of the fiber or grain. Records of the Hartford Company abound in instances of failure of horizontal return-tubular boilers with the shell plates curved by the boilermaker in the direction of the shorter dimension, thus eliminating the middle circumferential seam, but having the two longitudinal seams running the entire length of the steel, one on each side. Simi-

[1] For the provisions of the Boiler Code of the American Society of Mechanical Engineers see the editorial on page 268.—Editor.

lar has been the experience of the British Columbia Inspection Board. Indeed, a registered design for logging boilers of this objectionable mode of construction had to be withdrawn because of disastrous explosions in the case of two boilers and timely detection of dangerous grooving in several others.

From the experiences noted it seems safe to assume that the rectangular plates supplied to the boilermaker are fibrous in the direction of their greater dimension, and further, that the boilermaker who ignores this in shaping the plate to the curvature of a boiler shell really maltreats his material when he bends it in the direction of its shorter dimension. In effect, he opens the grain and creates incipient grooves or cracks, which small beginnings develop quickly when the boiler is put into operation. Perhaps it should have been mentioned, in regard to the series of logging-engine boilers of British Columbia design, that consequent to their ill fortune a more stringent bend test, similar to the British Admiralty requirements, was enforced. The alarmingly high percentage of failures of crosswise strips was such that this practice had to be abandoned. The material concerned was the ordinary boiler plate secured from the various reputable steel mills of this continent.

Rolling Induces a Fibrous Texture in the Direction of Rolling

If, then, there are strong reasons for concluding that from an ingot nonfibrous in texture the process of rolling to plate form induces a fibrous texture in the direction of the rolling, may the conjecture not be hazarded that there are other effects due to the same process? When dealing with an admittedly mysterious and illusive chemical compound like steel, a little speculation in a guarded way may be permissible, with the object, in this instance, of finding a possible explanation of the sometimes marked difference in behavior of test strips from the same plate when bent in opposite directions.

The problem may be stated in a general way thus: Are the molecules on one side of the neutral axis of a steel plate so arranged that tension can be withstood better than by the molecular structure on the opposite side of the neutral axis, and vice versa in regard to compression? And does the process of rolling from ingot to sheet support such a hypothesis when the process is minutely subjected to systematic observation, taking cognizance of the thermal conditions of ingot and rolls relatively from start to finish, the forces that cause the rolls to rotate and whether these forces possibly tend to put more work into one side of the sheet than the other? The remedy for the latter would be a highly complex machine that would automatically flip, or turn upside down, the embryo plate at every reversal of its movement between the rolls. The investigation might with advantage follow the finished plate to the pile to see what influence its fellows in a different thermal state might exert there.

This opens a wide field of inquiry that could be undertaken only by the expert thoroughly conversant with steel rolling-mill practice. Probably the voluminous literature of steel making contains something in regard to these points; but after fairly wide reading, reference to the deleterious effects of careless piling of the finished plates is the only one that comes to mind. If the phenomena specifically mentioned have been to any extent discussed, such discussion has not received the publicity it deserved and it would undoubtedly be welcomed by all parties concerned, especially the users of such plates.

The famous Disraeli epigram, "What is new is not true and what is true is not new," may be applied to these notes by the erudite metallurgical specialist; but when the great masters of the subject, like Williams, Hadfield and others, use the word "mysterious" in regard to steel phenomena, the smaller thinker may be excused for putting forth a query respecting queer happenings that have chanced experimentally within his own ken.

By way of emphasizing the fact that, in steel, surveyors, inspectors and engineers handle an extremely whimsical form of matter and that to dogmatize on the sufficiency of the physical tests prescribed by the rules of the superior authorities may lead away from the interests which those rules are intended to conserve, let me conclude with an account from the Dec. 11, 1914, issue of London *Engineering*.

Remarkable Failure of Steel Ship Plates

The record is one describing the remarkable failure of a consignment of steel ship plates. The material had been classed as excellent by Lloyds' surveyor in that it had fulfilled all requirements of the rules as regards testing. After having been flanged and riveted in place near the keel, cracks in profusion developed between rivet holes and from holes to edges of plates. All the plates of that charge were of necessity replaced by others. The case was referred to high authority in the person of Prof. J. O. Arnold, of Sheffield University, who, from analysis, concluded that the steel was "not of very good quality." From micrographic examination the material appeared to have been "overheated in the manufacture and gravely injured by the operation." Under alternating-stress tests conducted according to the Sheffield University standard, the results were "extremely unsatisfactory."

The following quotation from such an authority contains something very pertinent to what was intended to be the gist of these notes. He says in the report: "This is the worst steel of its class I have ever examined under alternating stress. I have not had the tensile tests made, as in such cases these would be of very little use, usually giving very fair results. As regards the bends, I send also three of the bars used in the alternating-stress tests. As you will see, they have bent double without any sign of a flaw. This also is quite usual." All of which seems to spell confusion worse confounded as regards physical tests for steel plate, with perhaps the alternating-stress method appearing as the faint silver lining in the cloud. The subject is full of interest, but space forbids further discussion. On another occasion the question of bend tests and the way in which the behavior of test specimens is influenced by process may be further inquired into. The specific mention, for instance, of a "press" in the British Admiralty rules is quite significant and should be rather reassuring to the steel manufacturer who is nervous about the crosswise-strip bend test, in that no time limit for the operation is stated. However, enough has perhaps been suggested by these remarks to disabuse some minds of the delusion that steel is always steel in the figurative sense; and possibly an avenue of thought has been crudely blazed for others to whom these observations are not altogether new.

Cores and Coils for Transformers—II

By ARTHUR PALME
Engineer, Transformer Engineering Department, General Electric Company

Construction and forms of coils used in different types of transformers are discussed. It is shown how the forms of coils have changed to meet the increased capacity and to make possible the insulating of modern high-voltage transformers. The method employed to prevent distortion of the coils due to the tremendous forces set up when a short-circuit occurs is touched upon.

IN a previous article the structural details of various types of transformer cores were considered; in this the various types of windings in modern transformer practice will be discussed. As stated in the former article (Aug. 5 issue), the winding of a transformer consists of two sets of coils, called the primary and the secondary. These two windings are electrically insulated from each other and the iron core. Only in very rare cases, that is, in all so-called "auto-transformers," are the two windings electrically connected.

According to the fundamental laws of electrical induction the secondary winding of a transformer will produce a voltage equal to the voltage impressed upon the primary winding divided by the ratio of the number of turns in the two windings. Thus if a transformer steps up 2300 volts to 50,000 and the primary

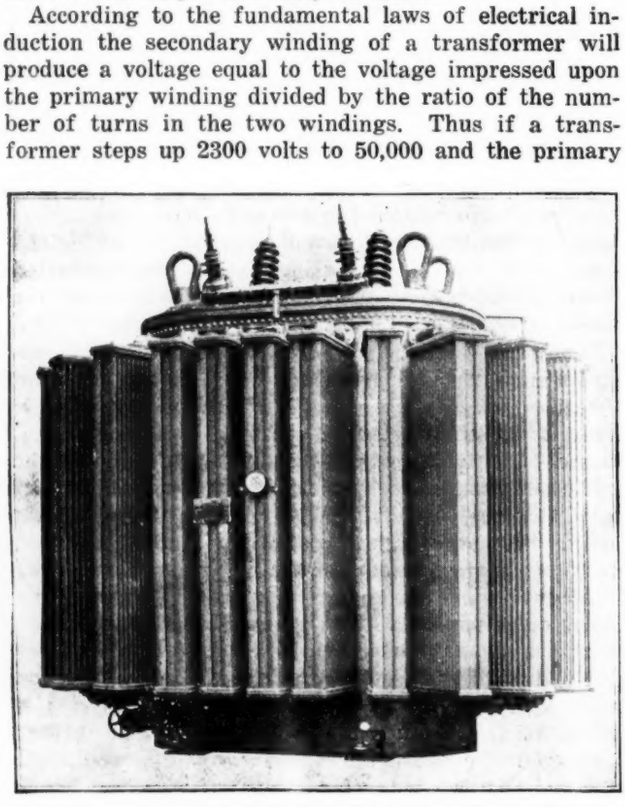


FIG. 1. RADIATOR-TANK TYPE TRANSFORMER

contains 100 turns, its secondary must have 2174 turns, because 50,000 divided by 2300 is equal to 2174 divided by 100.

Every transformation of electrical energy will be accompanied by losses which manifest themselves ultimately as heat. As the windings of a transformer cannot be allowed to get hotter than maximum 105 deg. C., or damage to the insulation will result, it is necessary to provide some means to carry away the heat at such a rate as to keep the windings below the critical temperature. A great many cooling methods are being employed, differing according to the size of the transformer and the local conditions. Such cooling methods have been fully described in an article, "Methods of Cooling Transformers," in the Dec. 25, 1917, issue.

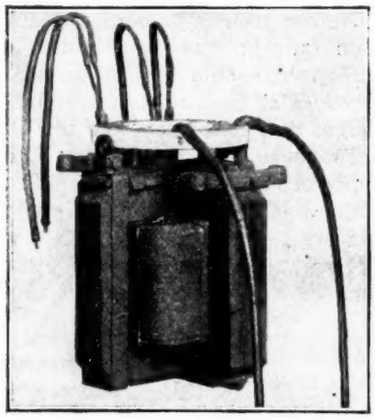


FIG. 2. DISTRIBUTED CORE-TYPE TRANSFORMER

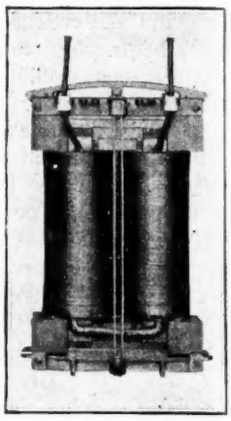


FIG. 3. CORE-TYPE TRANSFORMER

Before starting the design of a transformer, the method of cooling must have been decided upon. This is necessary because the different methods of cooling are capable of carrying away different amounts of heat, so that the smallest allowable cross-section of the conductors in primary and secondary windings depends directly upon the rate of dissipation of heat. In other words, a transformer may be designed with less copper if a quicker cooling method is used. On the other hand, quicker cooling will require a higher mechanical investment, so that it comes finally to a compromise between copper and cooling method.

Increase the Cooling Surface

Most modern transformers are indirectly oil-cooled; that is, the oil is the agent to transmit the heat from the windings to the heat-dissipating medium. As such a medium the tank containing the transformer and the oil may be used, or if its surface should not be sufficient, various methods of increasing it can be employed, such as corrugations, external tubes or radiators. With the last-mentioned method (radiators) enough surface can be obtained to dissipate the losses of even the largest units. An 8000-kv.-a. three-phase 44,000- to 6600-volt radiator-tank type transformer is shown in Fig. 1. However, sometimes the cost of this method or the large floor space required by such a transformer is prohibitive. Then water cooling has to be resorted to, which consists of a steel or copper cooling coil, submerged in the oil, and through which cold water is continually passing.

Every transformer is wound with some form of copper wire. For small output or very high voltage —in other words, for small current—round wire is being used. For larger currents a copper strip enables easier winding and better space economy. Copper-

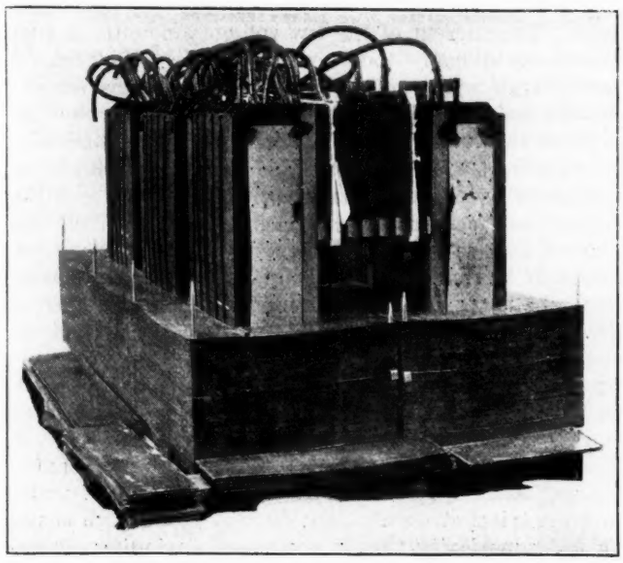


FIG. 4. SHELL-TYPE TRANSFORMER, CORE PARTLY ASSEMBLED ON COILS

rolling mills manufacture such strips in a great variety of sizes, from square to rectangular cross-sections. To insure reliable insulation these cross-sections usually have slightly rounded corners.

A great economy in space has been obtained by winding a rectangular copper strip edgewise. This was found especially valuable on the barrel coils to be mentioned later. It is obvious that by winding a thin rectangular copper strip edgewise a great many turns can be placed in a single layer.

The most important requirement a transformer must fulfill is the safe separation of the high- and low-voltage windings. It can be easily imagined what disastrous consequences would result if on a transformer of, say, 20,000 to 110 volts a connection should be established between these two circuits. In order to safeguard as much as possible against such a breakdown, it is customary to use in all transformers sufficient insulation to stand up under a test voltage very much higher than the rated voltage. On the conductors themselves enamel, cotton and paper are today the most widely used insulating materials. They all withstand any action of the oil, and even when oil-soaked are good insulation. All finished windings should receive a heat treatment with varnish or compound in a good vacuum for many hours, followed immediately by a similar treatment under high pressure. This removes all entrapped air and forces the insulating compound into the windings.

Expose Winding Surface to the Oil

The next important requirement is to expose as much as possible of the winding's surface to the oil. In former days, when the output of transformers was not very large and consequently the losses did not amount to much, the cooling of the windings was not difficult.

All types in small sizes, generally using distributed cores, Fig. 2, are wound solid. This means that directly upon the insulated iron core are wound the low-voltage layers, then follow a heavy insulation and the many high-voltage turns. The cooling oil has, therefore, only access to the outer surface of the high-voltage winding. The losses in such transformers amount to such a small amount that they can be easily radiated by the outer surface of the winding alone.

Transformers of larger output are provided with an oil duct between the core and the inner surface of the low-voltage winding and another concentric oil duct between the low-voltage and the high-voltage windings. There are, therefore, four surfaces of the entire winding exposed to the oil. Such a winding is called a concentric or barrel-type winding. The low-voltage winding in this type, placed generally next to the core, consists frequently of one or more cylinders built up of an edge-wound copper strip.

For still higher capacities, additional cooling is necessary; this is obtained by subdividing the high-voltage winding in two concentric barrels, giving a total of six or more cooling surfaces.

Up to about ten years ago core-type transformers with barrel-type windings, Fig. 3, were, in this country, limited to 400 kv.-a. or thereabouts. If larger capacity was desired, it was generally built as a shell-type transformer, Fig. 4. The many thin and long rectangular coils of this design gave a large oil-exposed surface, and consequently enabled the winding to dissipate considerable losses.

Circular Disk-Coil Design

The present trend is toward another way of obtaining large coil surfaces, and that is the circular-disk coil design, Figs. 5, 6 and 7. As previously shown, additional coil-cooling surface was reached by the barrel-type winding by dividing the necessary number of turns in two or more concentrically arranged cylinders, with oil ducts between them. The principle of the disk-coil winding is the division of the winding in the horizontal way; that is, by building up the entire transformer stack of thin disks with horizontal oil ducts between. This method is sometimes called a "pancake" winding. The height or thickness of each disk is made very small, rarely more than half an inch. In winding with a strip, the thickness of the disk is equal to the long dimension of the strip plus twice the amount of the insulation upon it. Thus every disk represents a spiral.

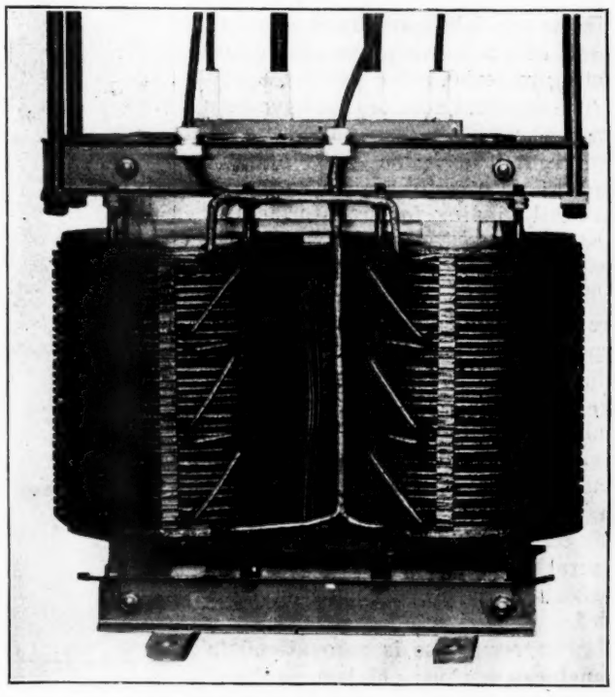


FIG. 5. SINGLE-PHASE DISK-COIL TYPE TRANSFORMER

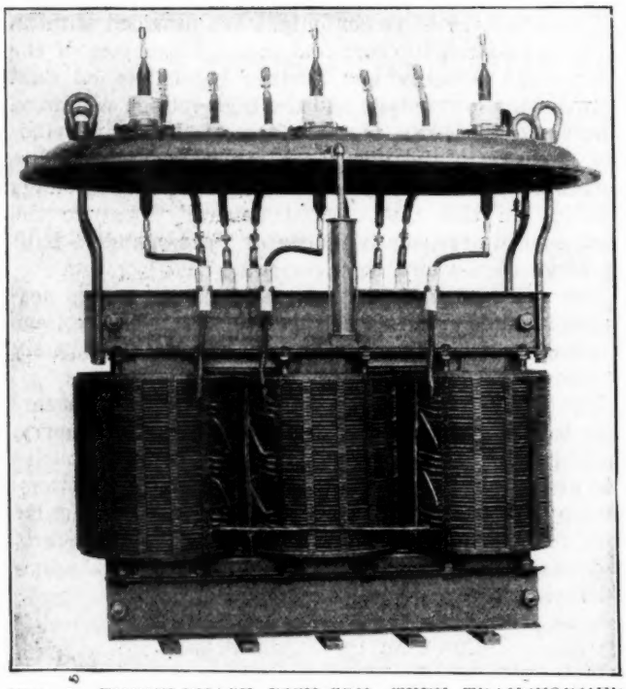


FIG. 6. THREE-PHASE DISK-COIL TYPE TRANSFORMER

like the hairspring of a watch; the winder begins at the inside and winds one insulated turn on top of the other until the desired total width of the coil is reached. Such coils are almost invariably wound circular. The distance between the individual disks is governed by the voltage induced per disk, and should be sufficiently large to secure an effective oil duct. With the exception of transformers for very high voltage, a disk-coil winding is usually arranged interleaved. This means that the total number of necessary disks for the low-voltage and the high-voltage winding is divided in two or more groups, and these are then stacked up alternately. The necessary distances between adjacent disks are maintained by a number of narrow radially arranged spacers, made of good insulating and oil-resisting material.

The excellent results that have been obtained with the distributed-core design made it desirable to combine this type of core with the advantageous disk-coil winding for transformers of moderate capacities. This led to the design shown in Fig. 8.

Transformers for very high voltages are usually wound as cylinder-disk type. This means that the low-voltage winding is made of one or more cylindrical, edgewise-wound barrel coils and is placed next to the core. The high-voltage winding consists of a stack of disks arranged concentrically on the outside. For small currents disk coils are wound with round wire, several turns high per layer per disk; for large capacities copper strip is used.

An extreme case is encountered in transformers of very high current and relatively low voltage, Fig. 7, such as now used frequently for welding purposes or in furnace work. The current of the low voltage amounts, in such instances, to many thousand amperes. This requires such a large copper cross-section (several square inches) that a great number of copper strips have to be combined to form the conductors, and are wound simultaneously.

In conclusion, a few words should be said concerning mechanical stresses in transformers. It is a little-appreciated fact, among electricians and operating engineers, that in every transformer there are set up considerable mechanical forces during its normal operation. In times of overloads, and especially so during short-circuits, these forces are sometimes tremendous, amounting to many tons. They are caused by the repelling action between primary and secondary windings and by the tendency of the turns to embrace as much of the magnetic flux as possible. For a given transformer winding these forces can be calculated for any load or for a dead short-circuit. It is under such electrical stress that the circular-coil design shows its full superiority to any rectangular winding, as the latter tends to distort itself in such a way as to become as nearly circular as its inherent mechanical strength permits. In late years transformer design tends toward short-circuit-proof machines; that is, their electric characteristics are so chosen as to limit the mechanical forces during a short-circuit to such a safe amount as can be withstood by the coil-clamping device. For every transformer the forces developed during momentary overload and short-circuit should be calculated in order to provide for a safe coil-clamping structure. This consists usually of steel plates and structural steel, shown in Figs. 5, 6 and 7. The difficulty of satisfactorily designing such a clamping device lies in its dual purpose to withstand strong mechanical forces and being, at the same time, safely insulated for even the highest voltages.

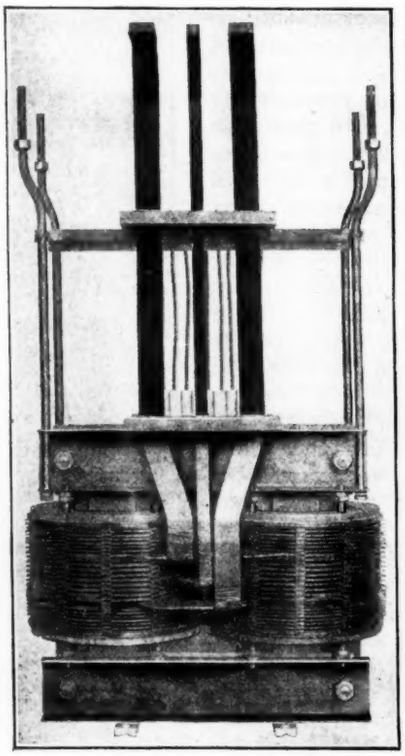


FIG. 7. LOW-VOLTAGE DISK-COIL TYPE TRANSFORMER

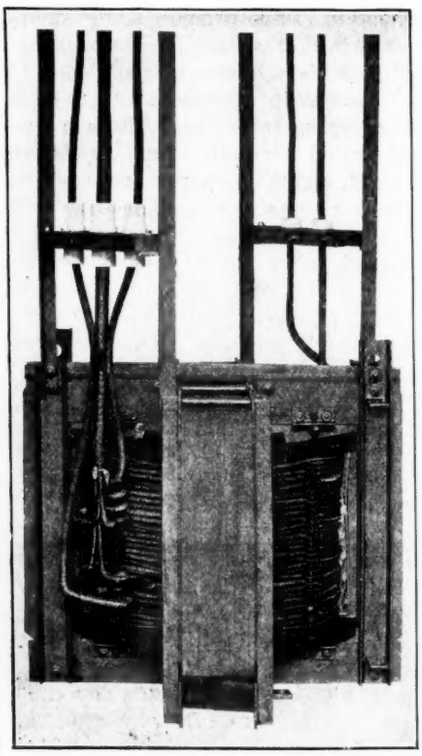
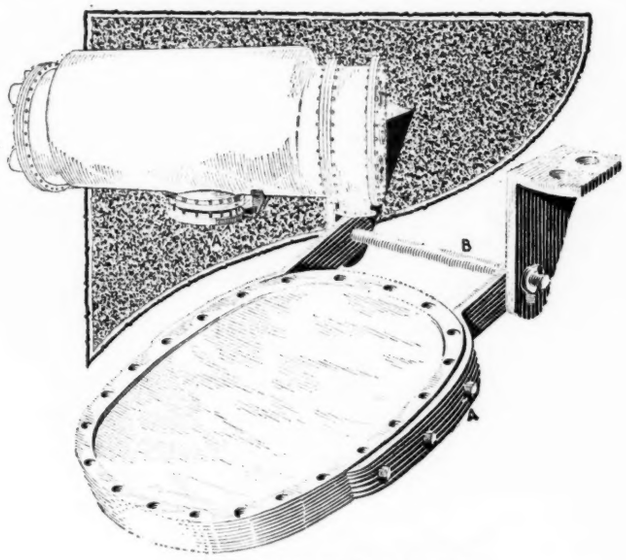


FIG. 8. DISTRIBUTED-CORE DISK-COIL TYPE TRANSFORMER

Rig for Removing a Condenser Plate

In a certain plant the surface condenser is fitted with a heavy removable cover plate at the bottom of the shell. Originally, the plate was held in place by studbolts, and when it was necessary to remove it the services of two men were required, one to hold the plate in position while the last two nuts were removed.

In order to make removal easier and also to reduce the number of men required to do the job, two ¼ x ½-in.



HINGED CONDENSER PLATE

iron straps *A*, to act as hinges, were bolted to the cover plate as shown in the illustration. The other end of each was drilled for a ½-in. rod *B*.

Bolted to the body of the condenser shell is a pair of angle irons spaced 8 in. on the inside. Each is made with an oblong hole, the object being to allow the plate to drop at the hinge end sufficiently to permit the plate to take a level position before the stud enters or leaves the holes in the plate. It is readily seen that with the aid of the hinges one man can easily remove and replace the plate, which hangs from the condenser while work is being done and is therefore ready to be replaced when desired.

The Refrigerated Purge Tank

BY H. J. MACINTIRE

Every engineer knows that from time to time it is necessary to purge the condenser to remove the inert gases from the system. Those inert gases may be air or decomposed ammonia, and their effect is to increase the head pressure. For instance, if the condenser pressure is 180 lb. and the condensed ammonia is at a temperature of 70 deg. F. (corresponding to a pressure of 114.5 lb. gage) then the difference, 65½ lb., is the extra amount against which the compressor has to work and which is a needless waste of energy.

The usual manner of purging is simply to open a valve at the top of the condenser and allow the gases to pass into a pail of water. Careful engineers make a point of stopping the compressor and keeping the cooling water on the condenser from half an hour to several hours before purging, the idea being that all the ammonia will be condensed and only the inert gases will remain. This is an improvement on the first method, yet it is becoming better known every day that a large amount of ammonia is lost through the purge valve.

This loss of ammonia is due to the fact that the law of partial pressures and the law of diffusion hold for ammonia as for a mixture of perfect gases. This means that the only advantage of running water on the condenser and stopping the compressor is to cool the mixture of gases and condense out *some* of the ammonia. We all know how it is that in cooling atmospheric air we first reach the dew point (where the air is 100 per cent. humid) and then any further cooling will cause precipitation of moisture. One way of *drying* air is to cool it, as is done in the low-pressure can agitation system using stationary air pipes. So, in the condenser, by cooling the mixture of the gases some ammonia is condensed and the remainder is weaker in ammonia content. But at no time will there be a stratum formed with air and inert gases on top and ammonia gas on the bottom. The mixture will be about the same in all parts of the condenser. Therefore, when any purging is done, ammonia as well as air is purged. But can any improvement be made?

In the small-capacity plant it is not worth while to do much of anything more, but the large plants should try to prevent this loss. It is not possible, by means of the condensing water, to cool sufficiently the gases being purged, but they can be refrigerated by means of a cooling coil in an extra header at the top of the condensers into which all of the stands are connected. In purging off, the procedure would be, as before, to stop the compressor and continue the cooling water over the condenser for some time, then open the expansion valve on the freezing coils in the purge header. The gas should be cooled to about 32 deg. F. or lower The gain to be expected may be seen by the following example, with a few assumptions.

Assume a condenser that has 1000 cu.ft. of gas volume, cooling water is at 70 deg. F., and half of the condenser volume is purged. (These conditions are rather extreme, however.) The condenser pressure is taken as 180 lb. as before. As the pressure in a mixture of gases is proportioned to the volumes present, we may say that the gas in the drum is composed of $\frac{65\frac{1}{2} + 14.7}{180 + 14.7}$ $= \frac{80.2}{194.7} = 41.2$ per cent. of inerts and $100 - 41.2 =$ 58.8 per cent. of ammonia. Suppose we cooled the gas in the drum to 32 deg. F. The condenser pressure will remain practically the same, but the percentage of the mixture will change, as at 32 deg. F. the vapor pressure of ammonia is 61.9 lb. abs. Therefore, $\frac{61.9}{194.7} =$ 31.8 per cent. = relative volume of ammonia present, and $100 - 31.8 = 68.2$ per cent. = relative volume of inerts.

In the first case 58.8 per cent. of 500 cu.ft. = 294 cu.ft., or $\frac{294}{2.3} = 128$ lb. of ammonia purged; in the second case 31.8 per cent. of 500 = 159 cu.ft., or $\frac{159}{4.82} = 33$ lb. of ammonia purged. The difference, 128 — 33 = approximately 95 lb. ammonia saved. At 30c. per lb. the gross saving is $28.50.

Advantage of Compression in Internal Combustion Engines

By J. S. A. JOHNSON*

THE ideal efficiency of any heat-engine cycle is equal to the difference between the heat absorbed by the working medium and the heat rejected from the working medium divided by the heat absorbed.

The common, or Otto, cycle is represented in Fig. 1, the compression and expansion strokes 1-2 and 3-4 being adiabatics while 2-3 and 4-1 are paths of constant volume. The heat absorbed along 2-3 is $c\ (T_3—T_2)$, while that rejected along 4-1 is $c(T_4 - T_1)$, the efficiency therefore is

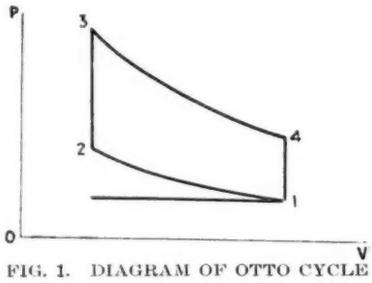


FIG. 1. DIAGRAM OF OTTO CYCLE

$$E = \frac{c(T_3 - T_2) - c(T_4 - T_1)}{c(T_3 - T_2)} = 1 - \frac{T_4 - T_1}{T_3 - T_2} \quad (1)$$

in which c is the specific heat of the working medium at constant volume and T_1, T_2, etc., are the absolute temperatures at 1, 2, etc. But

$$\frac{T_3}{T_2} = \frac{T_4}{T_1} \text{ and so } \frac{T_3 - T_2}{T_2} = \frac{T_4 - T_1}{T_1}, \text{ or } \frac{T_4 - T_1}{T_3 - T_2} = \frac{T_1}{T_2}.$$

Substituting in equation (1), the expression for the efficiency E becomes

$$E = 1 - \frac{T_1}{T_2} \quad (2)$$

Since 1-2 is an adiabatic whose equation is $p_1v_1^{\gamma} = p_2v_2^{\gamma}$, by combining this with the characteristic equation of a gas, $\frac{p_1v_1}{T_1} = \frac{p_2v_2}{T_2}$, it follows that $\frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)^{\frac{\gamma-1}{\gamma}}$ and this substituted in equation (2) gives

$$E = 1 - \left(\frac{p_1}{p_2}\right)^{\frac{\gamma-1}{\gamma}} \quad (3)$$

from which it will be seen that the higher the compression pressure p_2 for a fixed suction pressure p_1 the smaller will be the value of $\left(\frac{p_1}{p_2}\right)^{\frac{\gamma-1}{\gamma}}$, or $\frac{T_1}{T_2}$, and consequently the greater the value of E.

As the term compression conveys the idea of work done on the gas, it is often supposed that this work is lost. A moment's thought, however, will reveal the fact that even though no heat is supplied at the end of compression—no ignition of the fuel charge—reexpansion will occur during which the work that was previously done in compressing will be given back. In practice there will be loss due to leakage, friction and conduction of heat, but ideally, no resultant work is lost due to compression, to whatever extent it may be carried, when the period covers a whole cycle. Whether the actual cycle is of the two-stroke or the four-stroke type, it may be assumed that a constant amount of the working fluid is contained in the cylinder, and that the conditions are such that heat is supplied at constant volume along the path 2-3, and extracted at constant volume along the path 4-1.

An analogy may be of assistance in grasping the conditions resulting from compression. In Fig. 2, T_1 and T_2 are two storage tanks for supplying water to the pipe P. Should water be forced into the pipe from the level of the tailrace V to the height of the tank T_1, and then be lowered again to the tailrace level, no resultant work will be done, and this will correspond with the case of compressing the charge of a gas engine without ignition.

Now let us suppose that when the level S of tank T_1 is reached, a definite amount of potential energy in the form of water is delivered to the pipe P, the weight of water so admitted being represented in Fig. 3 by the horizontal distance FJ, the height above sea level being H_1, so that the energy supplied will be represented by the area $EFJM$. Should this water be discharged at the level V, the useful work done will be $FJRL$ and the energy lost $ELRM$, while the efficiency of the working water will be

$$E_1 = \frac{FJRL}{EFJM} = \frac{FL}{FE} = \frac{H_1 - H_0}{H_1} \quad (4)$$

Again, let it be assumed that the level of the cushion water reaches the tank T_2 and that the same amount of energy as before is admitted to the pipe, measured above sea-level. The area $BCDE$, Fig. 3, will represent this energy and be equal to the former area $FJME$. Since the altitude at which the working water is received is greater than before, a smaller quantity will be used for the same amount of energy, and accordingly

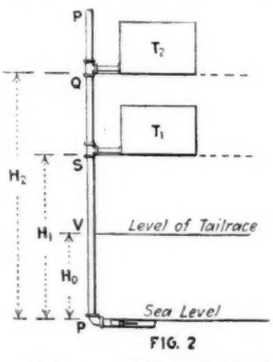


FIG. 2

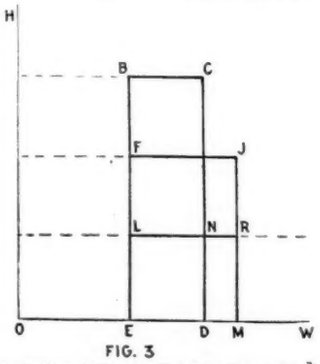


FIG. 3

FIGS. 2 AND 3. PUMPING WATER TO STORAGE TANKS AND DIAGRAM OF WORK DONE

there will be less energy thrown away at the tailrace level. The efficiency in this case will be

$$E_2 = \frac{BCNL}{BCDE} = \frac{H_2 - H_0}{H_2} \quad (5)$$

If H_0, H_1 and H_2 are respectively 200, 300 and 400 ft., the two efficiencies would be $E_1 = \frac{300 - 200}{300} = 33\frac{1}{3}$ per cent. and $E_2 = \frac{400 - 200}{400} = 50$ per cent.

The object of compressing the charge in a gas engine before ignition, or before supplying heat, is to reach as

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high a temperature level as possible, since in all cases in practice increase of temperature accompanies compression. There would, consequently, be little advantage in compressing isothermally, or below the isothermal—giving a lower temperature at the end than at the beginning of compression—however great the resulting compression pressure might be. Figs. 4 and 5 are useful in illustrating these heat relations. To whatever extent compression may be carried, it is assumed that a fixed amount of fuel with the oxygen supply necessary for complete combustion is present, so that when ignition takes place a definite amount of heat will be supplied. The two cycles, low and high compression, are shown on the *PV* diagram in Fig. 4.

In the analogy between mechanical energy and heat, head or height corresponds with temperature, while weight corresponds with heat-weight or entropy. Fig. 5 is therefore constructed with these coördinates, and any area on this diagram will represent heat units. The point *A* is at the temperature level of the charge at the beginning of compression, and the substance is compressed adiabatically to *B*. Should no ignition take place at *B*, the line *BA* will be retraced and no resultant work will be done and no heat lost. Normally, the charge is fired at *B*, the heat then being supplied at constant volume, the temperature rising to the level *C*

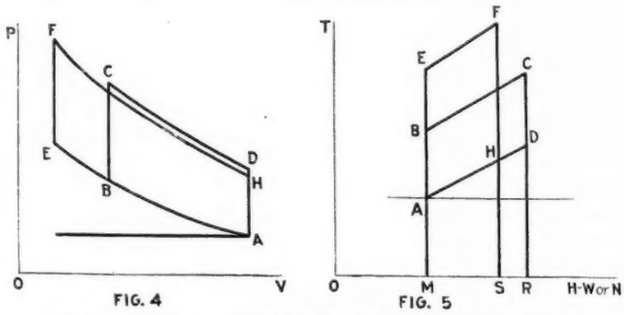


FIG. 4 FIG. 5

FIGS. 4 AND 5. DIAGRAMS OF WORK AND HEAT RELATIONS

along the path *BC*. The heat admitted will be represented by the area *BCRM*, *M* and *R* being at the sea level of heat or *absolute zero* of temperature. Should compression be carried to *E* before ignition and the same amount of heat be admitted, *EFSM* will be the corresponding area and must be equal to the former area *BCRM*.

For the low-compression cycle, heat will be rejected from *D* to *A* at constant volume, the heat thus rejected being equal to the area *DAMR* and the heat transformed into work in the cycle being *BCDA*. With the high-compression cycle the heat rejected will be *HAMS*, while the work done is *EFHA*. Since the two areas *BCRM* and *EFSM* are equal and the heat rejected for the high-compression cycle is less than that for the low-compression by the area *HDRS*, the work *EFHA* of the high will be greater than *BCDA* of the low by the same amount, and the efficiency of the high-compression cycle will accordingly be greater than that of the low-compression cycle.

The efficiencies will be: for the low,

$$E_L = \frac{BCRM - DAMR}{BCRM} \qquad (6)$$

and for the high,

$$E_H = \frac{EFSM - HAMS}{EFSM} = \frac{BCRM - HAMS}{BCRM} \qquad (7)$$

Consequently, since *HAMS* is less than *DAMR*, E_H will be greater than *E* and the advantage of high compression is accordingly evident.

Should the compression be isothermal a slight advantage would even then result with high compression, as shown on the diagram, Fig. 6.

For low isothermal compression, the heat supplied is *BCRM'* and that rejected is *DABM'R;* while for the higher isothermal compression, the heat supplied will be *EFSM"*, an area equal and similar in every respect to the area *BCRM'*, but the heat rejected is less than that for the low compression, being in this case *HAEM"S*.

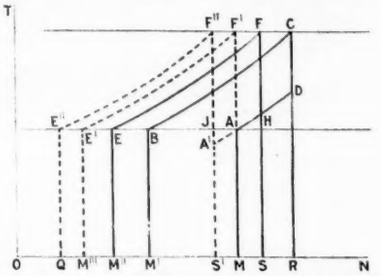


FIG. 6. SHOWING ADVANTAGE OF HIGH ISOTHERMAL COMPRESSION

If the isothermal compression is carried to a point *E'*, so that supplying heat at constant volume will produce the highest temperature at *F'*, a point vertically over the starting point *A*, the efficiency would be a maximum and the work diagram would be triangular, the three cases being represented in the *PV* diagram in Fig. 7.

It should be understood, however, that the conclusion drawn from equation (3), the expression for the efficiency in terms of compression pressure, to the effect that efficiency increases with compression pressure, is correct only for cycles in which the compression and expansion curves are isodiabatics—having the same numerical value for the exponent *n* in the equation PV^n = Constant—notwithstanding the fact that high compression is advantageous even though these two curves are not similar in the respect mentioned. For isothermal *compression* and, for example adiabatic *expansion*, there would be no advantage, but a distinct loss, in carrying the compression higher than *E'*, Figs. 6 and 7, resulting in a pressure at the end of expansion corresponding to the point *A'*, Fig. 7, less than the suction pressure *A* and giving a negative loop *A'AJ* on the heat diagram, as is shown in Fig. 6.

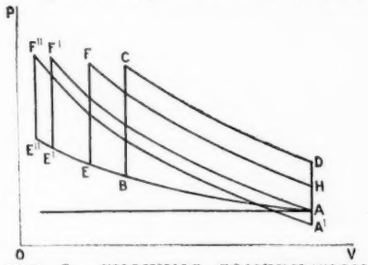
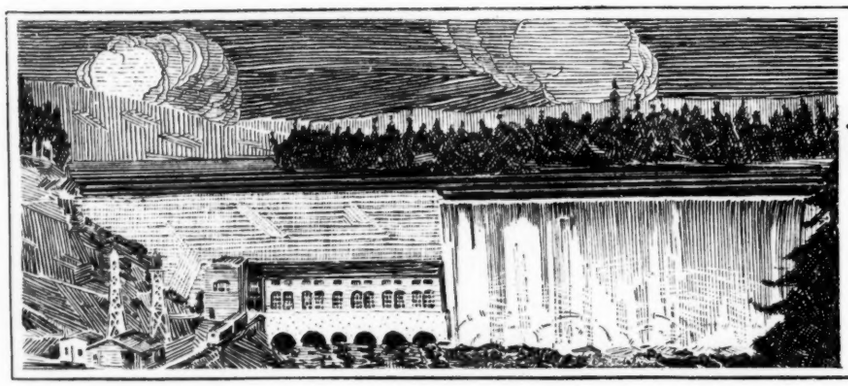


FIG. 7. SHOWING COMPRESSION FOR MAXIMUM EFFICIENCY

The injection of water with some fuels is supposed to prevent "cracking" and preignition by a reduction of the compression temperature. Although the primary object of compression is to raise the temperature level, the efficiency will increase with compression pressure even though there be no corresponding rise in temperature, and the advantage of high compression and water injection over low compression without water, but with the same final compression temperature, is evident.

Furthermore, the adiabatic expansion for steam is represented by a curve that is somewhat flatter than that for air or gas, and the expansion curve with water injection would accordingly be raised, giving a larger indicator card.



POP'S WATER-POWER COURSE

By

John S. Carpenter

AFTER Jimmy had finished his lunch of coffee and fried holes, alias doughnuts, he beat it back to the plant as fast as an aching corn would let him. There he found Pop waiting for him to begin the talkfest.

"Come on in, Jimmy," exclaimed Pop; "we'll make it two-handed! I jes' been figgerin' out a draft tube and scroll case fer fun."

Jimmy gazed in doubt at the wiggly thing, shown in Fig. 1, that Pop called a scroll case. "How drunk d'ye have to be to see things like that, Pop?"

"Draw up that chair," bellowed Pop with impatience, "and git out a pencil and paper! Let's say that our imaginary plant carries 200 cu.ft. per sec. to each turbine. Now we'll say that the head is 50 ft., which means that the turbines has about 100 hp. each at 88 per cent. efficiency. Good practice says that the water

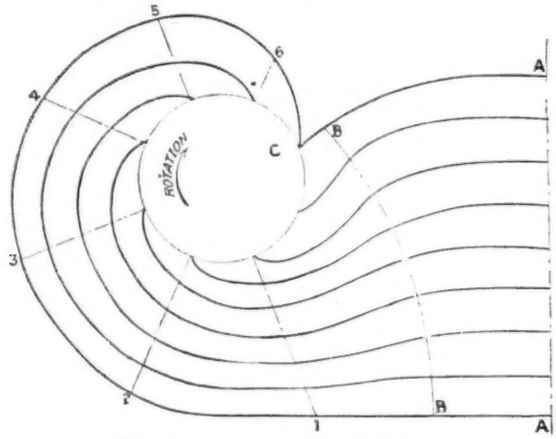


FIG. 1. PLAN VIEW OF SCROLL CASE

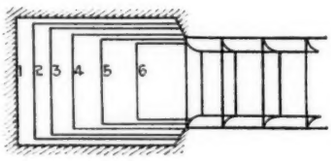


FIG. 2. SECTIONS OF SCROLL CASE

velocity at the inlet of the case should be about 15 to 20 per cent. of the spoutin' velocity, the lower the better, of course, so fur as friction is concerned. Now that means find the square root of 50, which is a oozlum more than 7, multiply that by 8, and take 15 per cent. of the answer." Pop ditched his chew and got busy with the pencil. "Jes' 8.4 ft. per second."

"Well, Pop, 200 cu.ft. per sec. divided by 8.4 ft. velocity gives us 23.8 sq.ft. area at the line *AA*."

"Yep, that's right. Now then, the water speeds up a bit in goin' to the line *BB*, jes' before some of it goes into the turbine. So from the point *C* to section 1 we figger that one-fourth of the whole amount has gone into the turbine because that distance around the turbine case is one-fourth of the whole circumference."

"I check you on that, Pop." A moment's thought occupied the two, after which Jimmy blurted out, "I guess, then, that section 1 should be just large enough to pass three-fourths of the full quantity, or 150 cu.ft., and between sections 1 and 2 we drop 25 cu.ft. more because that part is one-eighth of the circumference of the case. Therefore section 2 handles 125 cu.ft. per second."

"Great, Jimmy," beamed Pop; "you show signs of intelligence at times! Now then, jes' as you says, section 3 takes 100 cu.ft., 4 takes 75, 5 takes 50, and 6 takes 25. At the point *C*, theoretically there's none."

"Now our friend the lecturer," spoke up Jimmy thoughtfully, "he said that some engineers keep the velocity the same all the way down to section 6." Jimmy saw a great light mentally and was about to spring it, but Pop utterly squelched it.

"But before you can figger the width or height of any of the sections, we must first know what kind of shape we gonna make it. Them cases is sometimes made circular in cross-section and then they's also made rectang'lar. Mos' cases they's rectang'lar. Now we'll say that our case is 3 ft. high at section 1, and that the height drops 3 in. at each section line."

"That makes it darn complicated, Pop. Why do that?"

"It makes the sections, say from 4 down to 6, too darn high comparin' 'em to their width. The best way is to keep 'em as near square as you kin." Pop drew in the sections for each line from 1 to 6, as shown in Fig. 2. "Now then as we wuz told, some engineers makes them velocities decrease all the way from section 1 to 6, and they usually make the water at 6 run about 20 per cent. less speed than at 1. The idee is to make the friction about the same for all them slices of water, seein' that the water has to travel pretty far down to section 6. Now I skitched in the flow lines showin' about how the water is s'posed to go."

"Pop, don't forget that the lecturer said that the water does not flow quite so regular and smooth as you show it. There are big differences in velocities across a section, the water at the outside traveling slow, while as it moves in toward the turbine case it speeds up very fast."

"Ye-es," drawled Pop, "but that's got nothin' on what

happens in the inside of a draft tube at most any load, and which we'll dooly consider in a little bit."

"Yes, but why is it that they go to the expense of making a fancy scroll case when it seems that a square or a round hickey would do just as good?"

Pop adjusted his pinchers again, this time farther toward the end of that nose of generous length. "They claims that in the scroll case, when it's made accordin' to Hoyle, the water flows jes' as it natcherly wants to. In a square box, like in Fig. 3, there's dead water at points *A* and *B* and this jes' turns around like a whirlpool and makes extry friction. Now, in the case of a bastard scroll made by an offset circle, like in Fig. 4, the highbrow guys says that the water doesn't travel uniform and that the water is allus seesawin' back and forth through that narrer cranny. But, if they make the circle big enough, it won't be so bad, 'cause then the velocities is low and you know that friction varies as the square of the velocities."

"I feel satisfied that the scroll case is the real cheese, then; so now as you say, let's dooly take up the draft tube and tear it apart. First of all, just to start something, tell us in plain everyday lingo why the critter is and what right it has to existence."

"I git cher. The draft tube is a—is a—is a piece of pipe that goes in between the turbine and the tail water and does what it says, making more draft by slowin' down the water as much as possible. It may be long or short, straight or crooked, round or square, besides a lot of other shapes that would make a good boilermaker go on a drunk to try and cut out the plates fer sich a geegaw; but after all, the main thing is to slow up the water gradual-like, not too fast."

"It's as clear as mud to me now, Pop. Make some sketches and show us what you're beefing about."

Pop took another chew and then got the stubby pencil going.

"Well, the upper part of the draft tube takes the water right from the runner and at a high velocity;

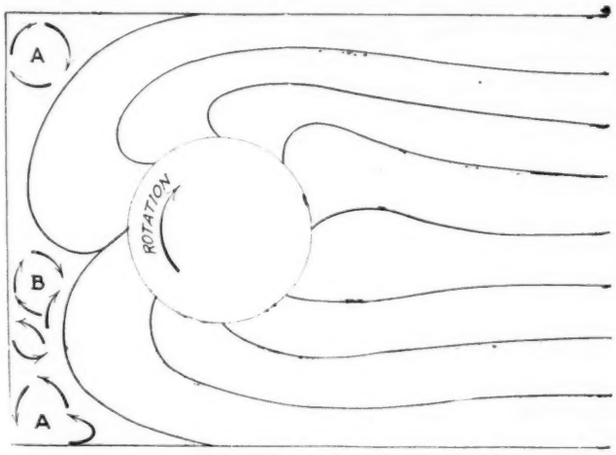


FIG. 3. EFFECT OF SQUARE BOX

from there on down the area of the draft tube gits bigger and so makes the water slow down, changin' kinetic energy back to potential energy. Potential energy is the kind of energy that a body may have 'cause it's high up in the air and in fallin' is capable of doin' work; while kinetic energy is the kind it has because it's in motion and kin do work by bein' stopped or slowed down. The great fact for you to git clear is that the sum of the potential energy and the kinetic energy is always equal to the total energy of the body, whether it's water or booze.

"Don't get you a-tall, Pop. Explain it better."

"Son, you git your pay in bills and coin. You kin always change one into the other, such as bills into coin and then back to bills again; but the sum total always remains the same—it's always so much money. So it is with energy. Git me?"

"Unless you spend some of it," suggested Jimmy cautiously.

"Somebody's allus takin' the joy outa life—now it's

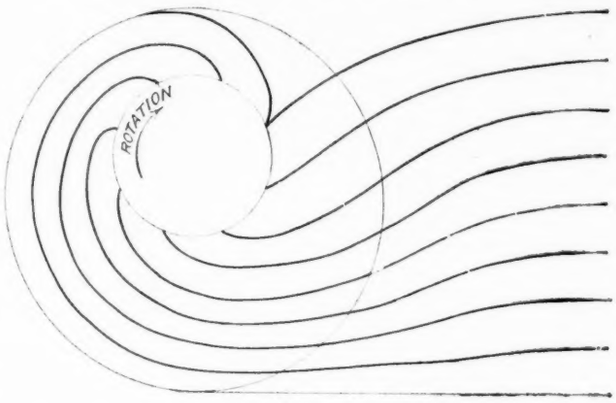


FIG. 4. BASTARD SCROLL CASE

you! Now, look at this here Fig. 5. Here is an example of a straight draft tube made of steel plate. It has a taper of 4 in. per ft., which is a whole lot, and that can only be used on very short draft tubes. I sketched out the velocity curve alongside. Now," said Pop, shoving Fig. 6 under Jimmy's eyes, "this is a concrete draft tube, and of all the pot-bellied things agoin' they kin do more deviltry in designin' these critters than you thinks. That one up at the plant is a peach. The designer wuz up thar and I ast him how many he had before he made that sprawlin' pipe. He looked at me kinder funny - like and I s'pose took pity on me. Then he says that on account of puttin' the units close together and in groups of two, they bent the draft tubes to fit. The construction foreman told me that as fast as he hired form-carpenters and showed 'em the drawin's they throws up and blows the job."

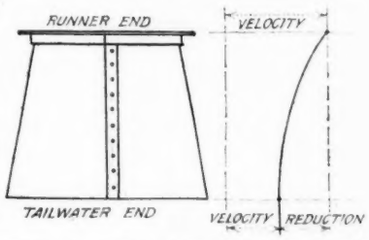


FIG. 5. STRAIGHT DRAFT TUBE AND VELOCITY CURVE

"Why in thunder do they give the bottom such a kick in the slats and flatten it out so?" said Jimmy, somewhat scornfully. "Seems like they made it uselessly complicated."

"They does that to save goin' down so deep with their foundations, and that saves concrete, too, see? Our friend the lecturer says he don't agree with some o' them fellers that makes the bottom end too flat. As we'll see later, at most all loads except that at which the runner works best, the water runs down through the draft tube with a sort of spiral action, like the thread on a bolt, and the flattenin' breaks up that turnin' motion, makin' more resistance to the flow."

"Now tell us what the permissible velocity through

the bottom end of the draft tube is. Mind that high-brow word 'permissible,' Pop."

"The lecturer said they usually uses 10 per cent. of the spoutin' velocity and which is none too low, either. Now, on our 50-ft. head plant we wuz makin' the scroll case fer, that would be 5.6 ft. velocity."

"And Pop, just the same as with the scroll case, the lower the velocity the better until the areas get too big by making the velocities too low."

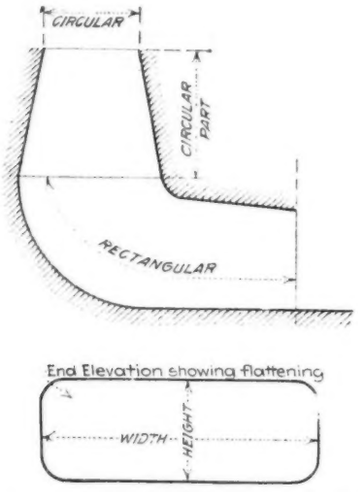


FIG. 6. CONCRETE DRAFT TUBE

"Yep, that's right. Jes' to make it complete, I sketched out the whole thing, here in Fig. 7."

"S'posin', Pop, they made the taper of the draft tube too great, what would happen?"

"I saw the lecturer off at Casey's Grill, and he gave me a whole earful on that. He told me about a big 4000-hp. turbine runnin' under 425 ft. head, speed 600 r.p.m.; some whopper of a machine. Well, after they got the thing finally set up in the plant and turned on the water, she spluttered a bit, and then got down to business, but she shook as if she'd have a conniption any minute, and she got worse as soon as they tried to put anything like full load on 'er. The big guys came in and give 'er the wunst over and told 'em to shut 'er down till they sends a man inside.

"The man came in, but he couldn't find anything incriminatin', so they tore her insides out and went over 'em with a fine-tooth comb. But that didn't help. Then they calls a council of war and trots in the royal family with the crown jools on and decides to brace her wherever they kin hang a few I-beams and tie rods. That helped some, 'cause then they had 'er tied down to solid rock; but the old rock gits a-shiverin', too. 'Bout then a broken-down college perfesser arrives on the scene and tells 'em where they spilled the beans. They plastered the inside of the draft tube so that the taper wuz right and the shakin' before usin' lays off."

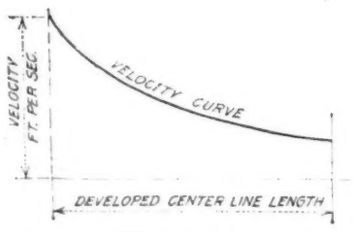


FIG. 7. VELOCITY CURVE IN CONCRETE TUBE

"Say," snickered Jimmy, "did the professor marry the boss's only daughter and then struggle along on a mere trifle of $5000 a year?"

"Dunno," growled Pop; "they probably gave him the price of a haircut and one-seventy-five a day while he kept sober."

Pop got up and stalked off into the boiler room. Suddenly he poked his head around the doorway and yelled, "Say, Jimmy, next time we study the turbine itself!"

Rules for Visitors in the Power Plant

By H. T. Moore

1. Upon entering the engine room, walk nonchalantly toward the nearest generating unit, scrape your feet on the guard railing, shake cigar ashes on the revolving commutator and spit in the direction of the switchboard. This careless attitude toward machinery will impress the engineer and reduce the likelihood of your being thrown out.

2. Ignore the engineer if he tries to engage you in conversation. He is a mind reader and a criminologist and will identify your name and business by your physiognomy and fingerprints. It is well to keep him guessing, especially if you object to his getting your number.

3. Wander around promiscuously, rubbing your hands on the polished parts and tracking coal dust in from the boiler room. The engineer is fond of housecleaning, and as a liberal stock of polish, lye, soap, water and mops is always on hand, he will enjoy scrubbing the floor after you leave.

4. It is always interesting to know whether the bright work, brass fixtures or bare pipes are smooth, rough, hot or cold. Handle everything in sight and urge others to do likewise if in doubt as to the physical characteristics.

5. If the governor pounds when the load changes, call the engineer's attention to the noise and tell him how to correct it. He is usually hard of hearing and wouldn't suspect it if you didn't tell him. He also appreciates free advice and may be willing to shut down the engine and make the needed repairs while you wait.

6. As the engine room is a lonesome place, stay around as long as you please, come often and bring your friends. The engineer is always glad to entertain visitors as he has nothing else to do but swear at the fireman and run a lunchpail cafeteria.

7. If you find the engineer removing the short from a short-circuit or removing a prime mover that is no longer in its prime, be sure to spring on him the funny story you heard at the pile drivers' convention. Stand in close proximity to his working zone and continue the mirth-provoking monologue until the external pressure against the seat of your trousers and your sudden departure through the nearest exit convince you that the interview has been terminated.

8. After inspecting the boiler gage-glasses, order the fireman to open the furnace doors to assist you in estimating the color of the smoke escaping up the chimney. Point out the air holes, leaky tubes and the impossible grade of fuel he is burning. These helpful hints may make him firing mad, but will temporarily increase his firing efficiency. The management appreciates humane suggestions affecting the morale of the boiler room, preferring to furnish pure carbon nuggets rather than have the coal heavers overworked or uncomfortable.

9. The danger signs in the high-tension room (or electrocution zone) are intended for ordinary workmen and wops and need not be taken seriously by civilians with insurance or bored persons looking for new sensations. Visitors desiring to poke canes or umbrellas at the high-voltage busbars to observe the corona effect should, however, write on their visiting card their choice of cemeteries and also leave their roll with the engineer before conducting any electrical tests. This foresight will save much time and expense.

The Electrical Study Course—Measurement of Alternating Current and Voltage

It is first shown that it is impossible to use direct-current instruments on alternating current, and then various types of alternating-current instruments are described. This is followed by an investigation of average and effective values of alternating currents and voltages.

IN ORDER to measure alternating currents and voltages, ammeters and voltmeters are used as in the case of direct currents and voltages, but the construction of the instruments is different. In Fig. 1 is illustrated the usual type of direct-current instrument. In it the pointer *a* is attached to the coil *b*, which is suspended between the poles *cc* of the permanent magnet *d*. When current passes through the coil *b*, it is caused to turn because it is in the magnetic field between the poles *cc*. Its motion is opposed by spiral springs *e*, whose tension is adjusted so that the distance through which the coil moves is proportional to the current through it. Such an arrangement would not serve to measure an alternating voltage or current, because the current passing through the coil *b* would be constantly reversing its direction, and consequently the coil would tend to swing back and forward in unison with the current. As a matter of fact there would be no motion of the coil at all, because the changes in current are so rapid that the coil cannot follow them; before it begins to move in one direction, the current through it has reversed and tries to move it in the opposite direction.

The objections to the direct-current type of instrument are overcome in one form of alternating-current

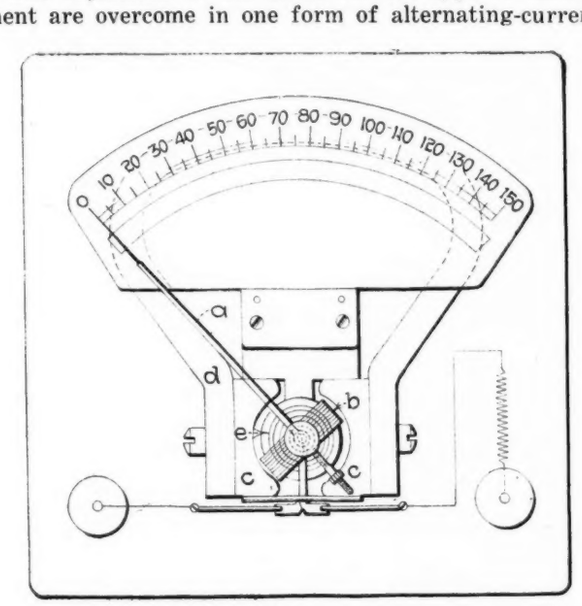


FIG. 1. INTERIOR CONSTRUCTION OF A DIRECT-CURRENT VOLTMETER

instrument by the use of two coils instead of a single coil and a magnet. A voltmeter of this type is illustrated in Fig. 2. The coil *b* is similar to the one in the direct-current instrument, but in place of the magnet the stationary coils *ff* are used. These are connected together at *g* and are in series with the resistance *R* and the coil *b* across the line, which is connected to the terminals *TT*. The coils *ff* are in effect an electromagnet, the magnetic field of which reverses for each alternation of the current through them. The coil *b* is situated in this field, and the current through it reverses in unison with the field. Consequently, the

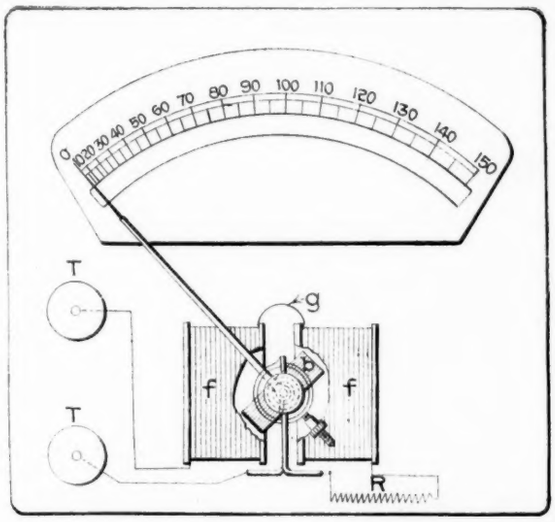


FIG. 2. INTERIOR VIEW OF THE CONSTRUCTION OF A TWO-COIL TYPE ALTERNATING-CURRENT VOLTMETER

force acting to rotate the coil is always in one direction and will cause it to move through a greater or less distance depending upon the magnitude of the current.

Another type of alternating-current instrument is the ammeter illustrated in Fig. 3, known as the inclined-coil type. A soft-iron vane *b* is mounted on a shaft, which is perpendicular to the base of the instrument. Vane *b* is mounted on the shaft at about a 45-deg. angle, and the coil *a* inclines at a 45-deg. angle with the base. When current flows through the coil *a*, a reversing magnetic field is set up by it. The vane *b* tries to turn into a position parallel to the field and in so doing causes the spindle and attached pointer to move. The amount of motion is controlled by a spiral spring.

In spite of the fact that the current which actuates them is constantly reversing, alternating-current instruments give constant deflections. The question then arises, What value does an alternating-current ammeter or voltmeter really indicate? At first sight the answer would appear to be, The average value of the instantaneous values. Thus, if the curve in Fig. 4 represent a voltage whose maximum value is 100 volts, the average of the instantaneous values for each half-cycle would be 0 + 50 + 86.6 + 100 + 86.6 + 50 divided by the number of values added together, namely, 6. Hence we have, average value of voltage $= \frac{373.2}{6} = 62.2$ volts. Owing to the fact that only a few values have been taken, this value is not strictly correct. The exact value is 63.7 volts. However, this average value is not the value that would be recorded by an alternating-current voltmeter, and as a matter of fact it is

of no importance in alternating-current practice and will therefore receive no further attention.

The value recorded by alternating-current instruments, and the one that is of supreme importance, is known as the *effective* value of current or voltage. An explanation of what this value is, is given in what follows:

In Fig. 5 is shown a direct-current generator G connected to a resistance R. Suppose the voltage E to be 200 volts and R to be 20 ohms. The current will then be, $I = \frac{E}{R} = \frac{200}{20} = 10$ amperes. The power used up in R is, $W = EI = 200 \times 10 = 2000$ watts. Since $E = IR$ we can also say that $W = IRI = I^2R = (10)^2 \times 20 = 2000$ watts. Or, since $I = \frac{E}{R}$, we could write, $W = E \times \frac{E}{R} = \frac{E^2}{R} = \frac{(200)^2}{20} = 2000$ watts. In other words, we have the choice of three ways of finding W. That is, $W = EI$, or $W = I^2R$, or $W = \frac{E^2}{R}$.

Suppose now that in Fig. 6 we have an alternator G connected to a resistance R of 10 ohms, and assume that the maximum value of the voltage of G is 100 volts, corresponding to the curve in Fig. 4. The power imparted to R will have a constantly changing value. When the voltage is zero we have $W = 0$; when it is 50 volts $W = \frac{E^2}{R} = \frac{(50)^2}{10} = 250$ watts; when it is 86.6 volts $W = \frac{(86.6)^2}{10} = 750$ watts; and when it is 100 volts $W = \frac{(100)^2}{10} = 1000$ watts. The average value of W for a half-cycle is therefore $\frac{0 + 250 + 750 + 1000 + 750 + 250}{6} = 500$ watts. Consequently, we have $\frac{E^2}{R} = 500$, where

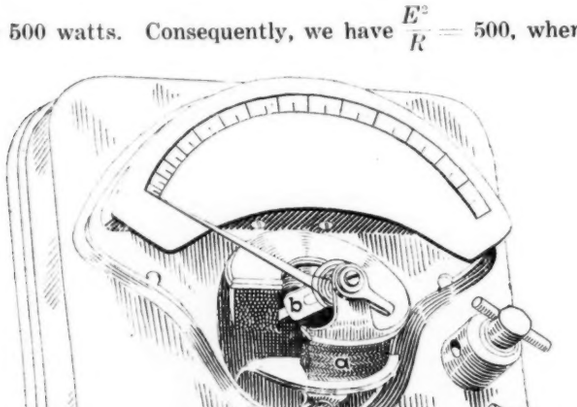


FIG. 3. INTERIOR CONSTRUCTION OF AN INCLINED-COIL TYPE ALTERNATING-CURRENT AMMETER

E^2 is the average value of the squares of 50, 86.6, etc., in Fig. 4. Since R is 10 ohms, we have, $\frac{E^2}{10} = 500$, or $E^2 = 5000$, from which we get, $E = \sqrt{5000} = 70.7$ volts. This is the effective value of the voltage; *it is the square root of the average of the squares.*

When the voltage is at a maximum, the current will also be at a maximum, and its value will be equal to $\frac{E}{R}$, or $\frac{100}{10} = 10$ amperes. The curve in Fig. 7 is a representation of it. When the current is zero $W = 0$; when it is 5 amperes $W = I^2R = (5)^2 \times 10 = 250$ watts; when it is 8.66 amperes $W = (8.66)^2 \times 10 = 750$ watts; and when it is 10 amperes $W = (10)^2 \times 10 = 1000$ watts. The average value of W for a half-cycle is therefore $\frac{0 + 250 + 750 + 1000 + 750 + 250}{6} = 500$ watts. It is seen that the I^2R method gives the same result as the $\frac{E^2}{R}$ method, showing that they check each other. From the result we have $I^2R = 500$, where I is the average value of the squares of 5, 8.66, etc., in Fig. 7. Since R is 10 ohms, we have, $I^2 \times 10 = 500$, or $I^2 = 50$, from which we get, $I = \sqrt{50} = 7.07$ amperes. This is the effective value of the current.

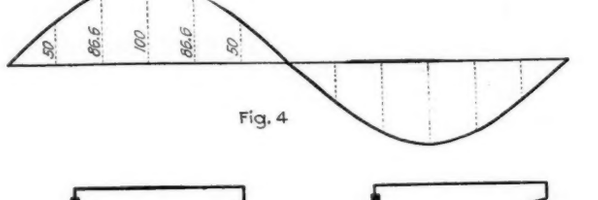


Fig. 4

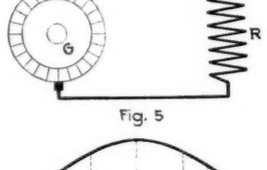


Fig. 5

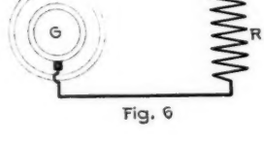


Fig. 6

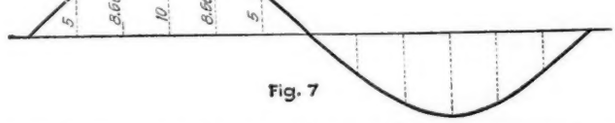


Fig. 7

FIGS. 4 TO 7. SINE CURVES OF VOLTAGE AND CURRENT, AND DIRECT- AND ALTERNATING-CURRENT GENERATORS CONNECTED TO RESISTANCES

If we multiply the effective value of voltage by the effective value of current, we have $W = EI = 70.7 \times 7.07 = 500$ watts, which again gives the same value as that already found and shows that the results are consistent. The effective value of voltage or current is always equal to the maximum value multiplied by 0.707. Thus, in our example we find, Effective voltage $= 100 \times 0.707 = 70.7$ volts, and Effective current $= 10 \times 0.707 = 7.07$ amperes. We therefore have the general rules, *effective volts = maximum volts* $\times$ 0.707, and *effective amperes = maximum amperes* $\times$ 0.707.

The effective values of current and voltage are the ones that are indicated by ammeters and voltmeters, so that whenever we speak of a current or voltage of a certain value we mean its effective value. For example, when we say that a current is 10 amperes, we should really say that the *effective* current is 10 amperes, but in practice the word effective is omitted; it is always understood that we mean effective if we say nothing to the contrary.

The first problem of the preceding lesson was to find the sum of two voltages differing in phase by 90 deg., one of which is 300 volts and the other 400 volts.

The vector diagram would be as shown in Fig. 8. The length of vector E_1 is made equal to 300 volts and is laid off vertically; the length of E_2 is made equal to 400 volts and is laid off horizontally, thus making the angle between the two vectors equal to 90 deg. The line CD is drawn through the end of E_2 parallel to E_1, and

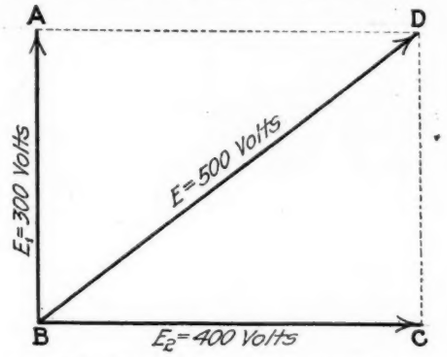


FIG. 8. VECTOR DIAGRAM OF VOLTAGES IN PROBLEM

the line AD is drawn through the end of E_1 parallel to E_2, thus forming the parallelogram $ABCD$. The diagonal BD is then drawn, giving us the vector E representing the sum of E_1 and E_2. Since BCD is a right-angle triangle in which the side CD is equal to E_1, we have, $(E)^2 = (E_1)^2 + (E_2)^2 = (300)^2 + (400)^2 = 250{,}000$, from which we get $E = \sqrt{250{,}000} = 500$ volts.

The second problem was to determine the speed at which a 12-pole alternator must run in order to generate a 50-cycle voltage. We know that frequency is given by the expression $f = \frac{PS}{120}$, and we therefore have, $50 = \frac{12 \times S}{120}$. That is, $50 = \frac{S}{10}$, from which we see that $S = 500$ r.p.m.

If the maximum value of the voltage in Fig. 4 were 311.13 volts, what would be the effective value? What current would flow if such a voltage were connected across a resistance of 4.4 ohms? If an alternating current voltmeter reads 120 volts when connected across an alternating-current source, what would the maximum value of voltage be?

Delegates to the Convention, National Association of Stationary Engineers

Power will again this year try to publish the photos of attending delegates in its convention fun maker, the *Power Pup*. Also each delegate will be given a package of cards bearing his photograph, name, position, association and city. But to do this we must have either your photograph or the electrotype we gave you at previous conventions, together with name, position, association and city.

All photographs must be of post-card size and show only head and shoulders—the three for a quarter kind will do. All photos must reach us by Aug. 20. No photos will be accepted at Huntington, as Huntington affords no facilities for making electrotypes.

Please call this to the attention of your fellow-delegates and mail your photograph or electrotype today. These cards will help you to associate the names with the faces of the many new friends you will make. Address, Editor of *Power*, Tenth Avenue at Thirty-sixth Street, New York City.

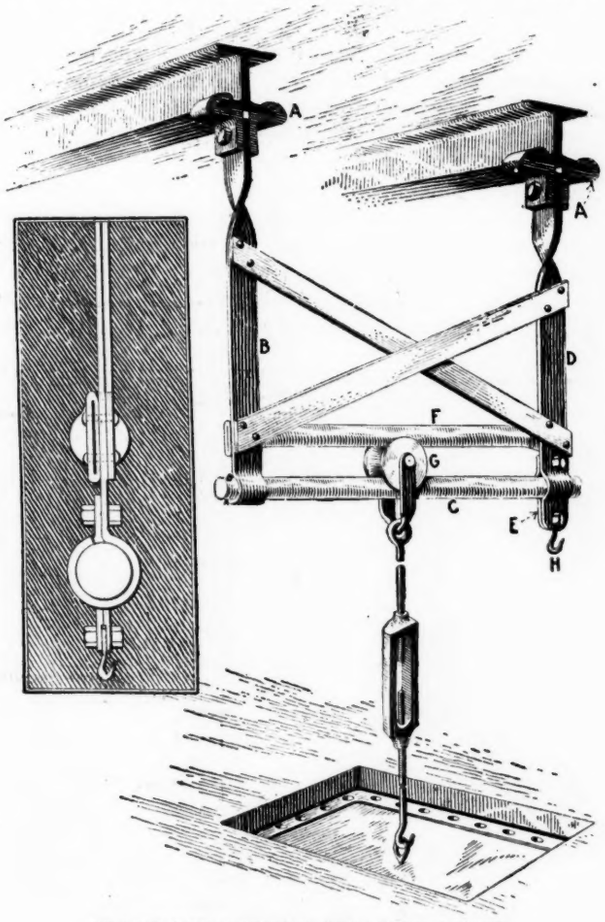
Strainer Cover Lifter

A labor-saving arrangment in the shape of a rig for lifting the cover of a large water-pipe line strainer is shown herewith. By means of this device one man now does the work that formerly required four.

Fortunately, two iron beams ran parallel along the ceiling of the basement. To each of these beams a two-piece clamp A was bolted, the clamping bolt also passing through a hole in one end of a piece of flat iron bar B and D, bent at a right angle so as to facilitate bolting the crossbars in place.

The lower end of the rod B is bent to hold a 2-in. rod C. The end of the rod D is made in the shape of a bearing, the cap E being secured in place by bolts. This supports the other end of the 2-in. rod, on which a roller G travels. A 2-in. guide rod F, the ends of which are flattened, is bolted to the crossbraces.

From a pin passing through the pulley G is hung



CRANE FOR LIFTING STRAINER COVER

a U-link, to which one end of a turnbuckle rod is hung. Another turnbuckle rod is made with a hook for engaging an eyebolt that is secured to the center of the strainer cover. At one end of the crane a hook H is attached, on which the eyebolt is held when not in use.

When the cover is to be lifted from the strainer, the hook of the turnbuckle is hooked into the cover eyebolt, and after removing the cover nuts the turnbuckle is screwed up enough to clear the cover plates from the studbolts. The roller and cover are then pushed to one end of the rail C until the cover is wanted for replacement.

Negus-Tiffany Coal Agitator

In the operation of underfeed boiler stokers trouble is frequently caused by the coal hanging up in the hopper. With dry fuel this does not occur, but with wet coal the stoker plunger is pushed through the fuel bed and upon the return stroke the coal fails to fill the cavity left by the plunger. The consequence is that the stoker does not work to capacity, the fuel may be unevenly distributed in the furnace, and air leak holes form. When coal hangs up in the stoker hopper, it is necessary to employ men to poke it down so that the plungers may receive a full charge of fuel.

That this hanging-up trouble of wet fuel can be taken care of by mechanical means may be seen by an examination of the accompanying illustration. This attachment shown is known as the Negus-Tiffany coal agitator and is manufactured by the W. E. Ellis Co., Haverhill, Mass.

This stoker agitator consists of agitating arms, the number depending on the size of the stoker and the number of stoker retorts. These arms are secured to a 1/32-in. shaft supported by suitable bearing supporting bars that reach across the bottom of the hopper. This part of the apparatus is placed at the bottom of the hopper (see Fig. 2), the agitators being spaced so that they come midway between the stoker plungers. The agitators are made of 2 in. wide by ½ in. thick metal, and the yoked ends are 1½ in. wide and ½ in. thick. The end next to the front of the stoker hopper is bent up at an angle of 30 degrees. Attached

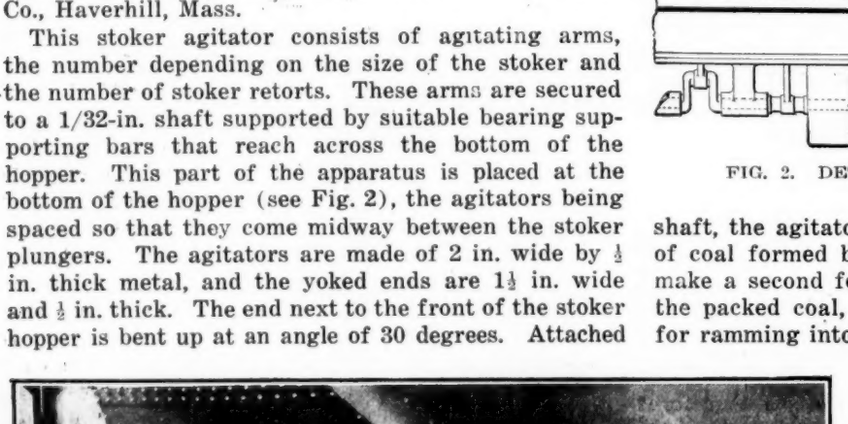


FIG. 1. COAL AGITATOR AS APPLIED TO A STOKER HOPPER

to the outside of the hopper is a bracket that carries a bell crank, one end of which is connected to the agitator shaft by means of a link connection. The other end is connected by means of a connecting-rod to a crank attached to the stoker ram shaft (see Fig. 1). It will be observed that the rod connection to the bell crank has a two-way motion at the same time. This requires a special design of joint, and it consists of a split bearing hollowed out on the inside so as to house a ball joint, through which a stud passes at right angles with the bell crank. The stud also passes through the end of the connecting-rod attachment, forming a type of universal joint.

The crank has a throw of 3 in. from the center, which gives a 6-in. movement of the bell crank. As the bell crank makes as many oscillations as the stoker

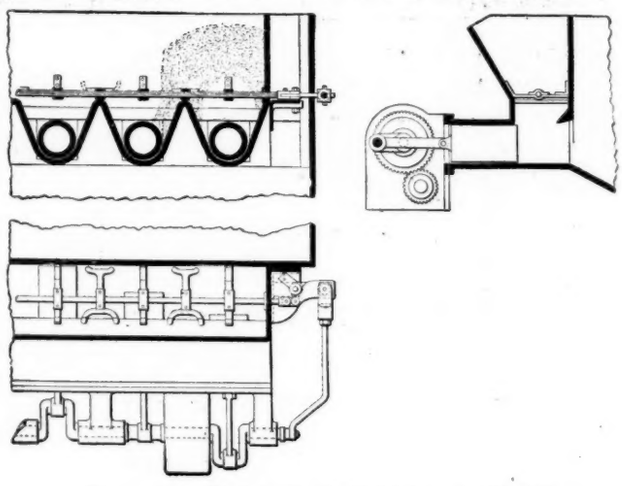


FIG. 2. DETAILS OF THE COAL AGITATOR

shaft, the agitator arms are moved across the bridge of coal formed by the plungers before the plungers make a second forward movement. This undermines the packed coal, and the plunger box is filled ready for ramming into the furnace. Thus a full charge of fuel is kept in front of the rams at all times.

In order to determine just what the apparatus would do, a well-known stoker engineer made many tests, even going so far as to turn the hose into the hopper which had been filled with coal and saturate the fuel, then tamping it as hard as possible with a tamping bar. Under this severe condition the device fed the coal without trouble, although the wet fuel nearly put out the fire.

The Minister of Railways has approved the project of the electrification of Belgian railways, and instructions have been issued to have plans submitted for the electrification of the line between Brussels and Antwerp and Brussels-Luxembourg, to be followed immediately with an electric line between Brussels and Ostend. The current will be supplied with overhead wires or the third-rail system, according to the location and circumstances. Work will be commenced at the beginning of 1920, and it is proposed that the journey between Brussels and Antwerp be made in 25 minutes and to run trains every 15 minutes.

Animal fats and grease never should be used on rubber belts. Boiled linseed oil is good; also equal parts of black lead, red lead, French yellow, litharge and enough Japan dryer to make it dry quickly.

EDITORIALS

Byproducts From Coal To Pay for Power

ONE of the greatest developments appearing on the horizon in the power-plant field today is suggested on other pages of this issue in an article on low-temperature distillation of coal, by C. M. Garland. The author points out that work along this line has been in process for the last fifteen years, the primary object being to make of bituminous coal a clean smokeless fuel for domestic and small-power use to replace anthracite, semi-anthracite and hard coke. All the gas generated is required in the coking process, but byproducts in the form of a light tar and ammonium sulphate, ranging in value from $2.50 to $3.50 per ton of coal treated, are recovered. These values make the investment worth while and permit marketing the coke at a favorable price.

In connection with large power work there are attractive possibilities for low-temperature distillation. The opportunity for effecting a saving, however, has not been great enough to encourage the larger investment required, and the initiation of a new enterprise requiring skilled attendance and perhaps some development to meet the specific conditions of the plant and of the fuel used.

As stated by the author of the article, there is greater outlook for a plant utilizing the low-temperature process to recover principally the tars and a byproduct gas producer of the Mond type to recover the ammonium sulphate. The value of the byproducts would be doubled and in like proportion the opportunity to effect a saving in power generation. As the primary product, the gas from the producer could be burned under the boilers as fuel or used directly in internal-combustion engines. It would contain about seventy per cent. of the heat in the original coal, and as it can be burned at higher efficiency under boilers, in the ratio of say, eighty to sixty-five for average everyday operation, its effective value would be about eighty-five per cent. of that of the coal. In other words, there would be only a fifteen per cent. loss over using the coal as fuel direct.

It has been estimated that the value of the byproducts would range from five to six dollars per ton of coal, costing in the first place from two and one-half to four dollars per ton, depending on the location of the plant with respect to the mine. On this basis it is evident that the byproducts would not only pay for the coal, but depending on the size of the installation, there would be a margin sufficient to cover the fixed and operating costs and perhaps provide a slight surplus. In brief, there is the possibility of making a gain of one hundred per cent. or more, simply obtaining the power for nothing.

Such a plan is essentially adapted to constant load, so that it is applicable to plants having a load of this character twenty-four hours per day and preferably the year around. In a large plant the system could be arranged, of course, to cover that portion of the production represented by the minimum load. For a paying investment the author gives as a minimum limit in size a plant burning fifty tons of coal per day of twenty-four hours, or roughly, a two-thousand-kilowatt installation. Such a plant would bring enough returns to pay for the coal. Its initial cost is placed at $150 per kilowatt, being divided into $85 for the power plant and $65 for the byproduct equipment. For a one-hundred ton plant the estimated cost is $125 per kilowatt, divided $65 and $60, respectively, with byproduct values sufficient to pay for the coal and all operating expenses. Doubling the plant capacity again would increase the economy sufficiently to also care for the overhead and possibly provide a surplus.

Such are the possibilities. The maximum gain could not be expected in the first plant, although satisfactory returns would be probable. There is need of pioneer work and development of the combination plant, which, unfortunately, does not lend itself to experiment on a small scale. For this very reason, even with such magnificent returns in sight, private capital may hesitate to venture into the unknown. Research of this character might better be conducted as a Government project, and the logical department would be the Bureau of Mines. Results available to all would be obtained more quickly, and the high reputation and impartiality of the Bureau would insure confidence in the work.

The component parts of the plant outlined have been operated successfully, and there are no insurmountable obstacles to designing a combination plant that would give satisfaction. In its operation it will require chemists and skilled engineers, but this is a day of progress, and being such, we no longer can afford to burn byproducts worth more than the original cost of the coal. A power-plant efficiency of one hundred per cent. would not permit it. Eventually, economics will dictate the distillation of coal to recover the byproducts.

New England Coal Again

ANOTHER attempt is made to work the New England coal mines, this time at West Mansfield, Mass. Newspaper propaganda, full of favorable comments of supposed authorities, says nothing of the vain attempts which have been made to mine and use this graphitic coal except that the mine has been worked "on and off" since 1835. Since only 30,000 tons are claimed to have been mined from the entire section and the capacity of this single mine is given as 200 tons a day, it is apparent that the operation must have been "off" most of the time.

The trouble is that the New England coal is harder than Pharoah's heart. It can be burned, but New Englanders have preferred to import coal that did not need so much urging. A few more coal famines like that of 1917, or the devising of methods for making it take its oxygen more willingly may bring about its utiliza-

tion; or perhaps it may be found more valuable for some other purposes than for fuel. Large deposits of carbon like these ought to find some use in the industries. Any attempt to exploit the mines, however, and especially to sell stock in them, ought to be made with a frank acknowledgment of the shortcomings of their contents as fuel and of the disastrous outcome of the many previous attempts to operate them. Such newspaper statements as that "Geological experts say that the district is rich with coal and that it can supply the needs of all New England" and that "according to tests the best grade of anthracite coal is to be found in this section," unqualified by such acknowledgments and admissions, throw considerable doubt upon the bona fides of the venture.

Physical Tests of Boiler Steel Plate

DESIGNERS and manufacturers of boilers will be interested in the article by Frederick Biggam, inspector of steam boilers for British Columbia.

It is easy to make rules and draw specifications, but in practice things are not always distinctively one thing or another, and vagaries of the sort described in this article may well puzzle the inspector.

The Boiler Code of the American Society of Mechanical Engineers prescribes that "Tension-test specimens shall be taken longitudinally from the bottom of the finished rolled material, and bend-test specimens shall be taken transversely from the middle of the top of the finished rolled material. The longitudinal-test specimen shall be taken in the direction of the longitudinal axis of the ingot, and the transverse-test specimen at right angles to that axis." When the sheet is curved, as is not usual, crosswise of the grain the tension-test specimens must be cut crosswise of the grain and meet the physical test prescribed. The bend-test specimen must bend cold through one hundred and eighty degrees without cracking, around a pin the diameter of which is equal to the thickness of the specimen for one-inch material and under or of a diameter twice the thickness of the plate if the latter is over an inch thick. There is no provision in the Code for any quench test.

The reference to the experience of the British Columbia Inspection Board with logging boilers made by curving the bottom sheet in the direction of the shorter dimension, eliminating the middle circumferential seam but having two longitudinal seams running the full length of the boiler, is interesting in connection with the discussion of the allowable length of longitudinal seams now going on in *Power*. We have asked Mr. Biggam to contribute at greater length to this discussion.

A. I. E. E. Proposed Changes in Activities

THESE are days of radical changes in about everything that affects the activities of groups of people, whether it be of nations or individual groups within the nation. Even bodies that in the past have been apparently immune from the influence of radical changes now find themselves carried along in the flood of unrest that is practically enveloping the world at the present time. The contemplated changes in the activities of the American Institute of Electrical Engineers, as proposed by the development committee and published elsewhere in this issue, are representative of the trend at the present time. Many changes have been made in the workings of the Institute since its founding in 1884, to meet the altered conditions in the electrical industry and the needs of the increased membership of the society, but none have been so radical, comprehensive and far reaching as the present proposed changes. Only the highest commendation is due the development committee for working out these changes to increase the usefulness of the society to its members. However, where such far-reaching changes are contemplated, they should be put into effect only after the most serious consideration.

An engineering society in the past has in general been looked upon as an institution apart from and entitled to and allowed privileges not granted to commercial organizations. What the effects of an attempt to commercialize the *Proceedings* of the institute would be is difficult to foresee. However, there are many members of the highest professional standing that are opposed to any such move, as they feel that the prestige and independence of the institute will be decreased. There is little doubt that many of the proposed changes, if put into effect, will enhance the value of the institute to its membership, but careful consideration should be given to the departure in policy, or else the work of the past thirty-five years of building the American Institute of Electrical Engineers up to its present high standing as a national technical society may be seriously impaired.

The latest estimate of the power used in the industries of the United Kingdom (exclusive of that used in blast furnaces, gas works, etc.) is given in the report of the British Government Coal Conservation Committee as 10,024,996 horsepower. From other sources it is estimated that for every person engaged in industry in the United Kingdom about one-half a horsepower is available, in Canada about three-quarters of a horsepower and in the United States one horsepower.

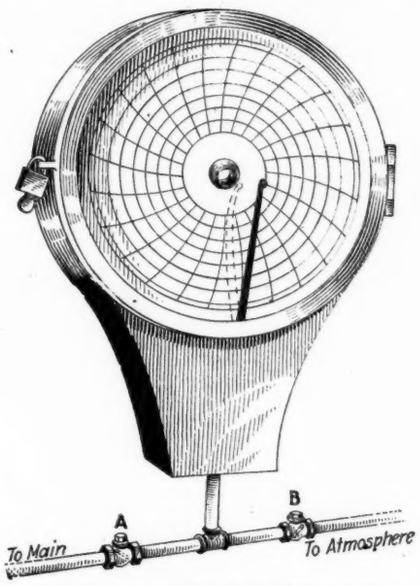
Periodically, peat has come to the foreground as a suggested substitute for coal in power generation, and in isolated instances it has been so used, but thus far it does not appear to have offered sufficient inducements to warrant adoption on a large scale. Reports now come from Moscow, however, that due to absence of water power and the gravity of the coal situation the Council of Public Economy of that city is now planning to erect a large electric power station near the peat beds.

In spite of pressing need for legislation and the momentous questions now before the Senate, that body has found time to again pass a daylight repeal bill. Judging from this the League of Nations, the railroad situation, the high cost of living and the need for water-power legislation all appear insignificant beside the invisible pressure that must be behind that extra hour of darkness. It is assumed, of course that the President will again use his veto power.

Correspondence

Check Valves in Recording Steam-Gage Piping

In order to protect a recording steam gage from the strain of having to stand under a vacuum, which was formed in a long steam main each time the line was shut off, a check valve, as shown in the illustration at *A*, was put in the line to the gage, as it was not desired



CHECK VALVE IN GAGE LINE

to have the vacuum broken in the main stream line between the gage and the point of shutoff. It was then found that a vacuum still formed between the check valve and the recording gage and that it was strong enough to keep the pen pulled over to the center nut which holds the chart. This action, besides having a tendency to spring the pen arm, caused the ink to smear badly near the center of the chart and caused considerably inconvenience to the operator when renewing the chart, as the pen would be found sprung against the center nut instead of resting on the zero line, well away from the nut.

The arrangement of a second check valve *B* in the line to the gage, each check opening toward the gage, as shown, ended the annoyance. I. S. CHAMBERLAIN.

Jersey City, N. J.

Laundry Condensation Problems

In a certain large laundry the condensed steam from the ironing machines was handled by traps discharging into an open heater. A direct-return system, with a receiver located at the lowest point, was installed and all machines emptied into this receiver. This change resulted in a saving of thirty bushels of coal a day. Although the service was fairly satisfactory, there was always trouble with some of the machines becoming airbound and not heating properly.

Recently, a change in system was made whereby a non-return trap was installed for each machine and all traps empty into a steel tank located 12 ft. above the boiler and vented to the atmosphere. The tank empties into a direct-return steam trap, thence to the boilers. By providing a float valve for makeup water, the steam boiler-feed pump has been discarded.

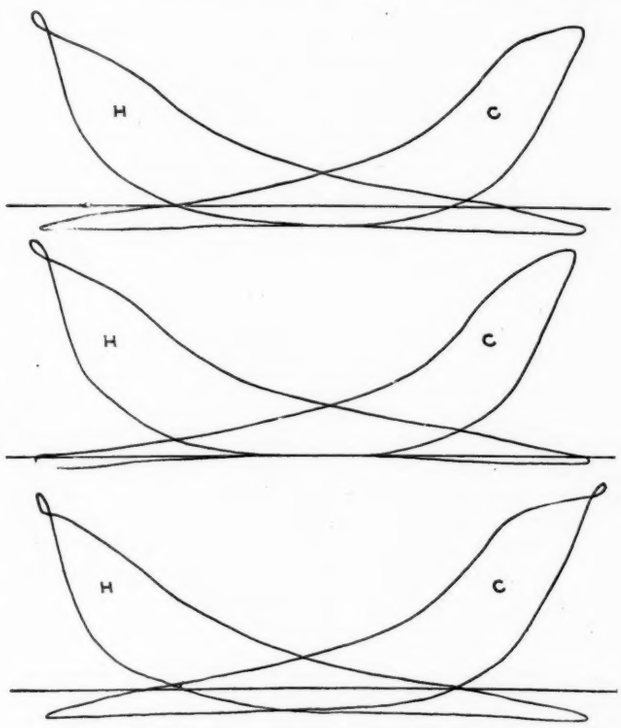
Although the condensed steam is now 212 instead of 280 deg., the efficiency of the ironing machines is so much greater that one machine increased its output from 23,000 to 40,000 pieces in nine hours.

The direct-return system is all right for one or two machines, but this system will give better results where there is a large number of machines.

St. Louis, Mo. H. C. JOHNSON.

Why the Atmospheric Line?

The accompanying indicator diagrams are submitted for criticism. The valve fitting can be easily improved, but that is not what is bothering me. The mystery about these diagrams is why does the atmospheric line appear, as is shown, on a noncondensing indicator dia-



NOTE ATMOSPHERIC LINE ON NONCONDENSING INDICATOR DIAGRAMS

gram? The engine runs at 200 r.p.m. with 90-lb. gage pressure noncondensing and carried a load of 225 amperes at the time the diagrams were taken. A 70 spring was used.

What is the opinion of *Power* readers regarding the position of the atmospheric line and why?

Washington, Penn. M. J. ILES.

Connecting Cable to Live Bus

When electrical power plants or substations make changes, repairs or additions, it is often necessary to work on live circuits to avoid service interruptions. A little planning will at times bring to light some method to solve these problems without working on live equipment.

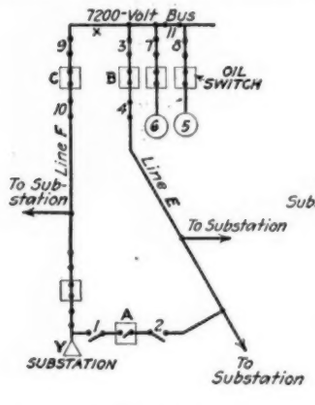


FIG. 1. NORMAL CONNECTIONS

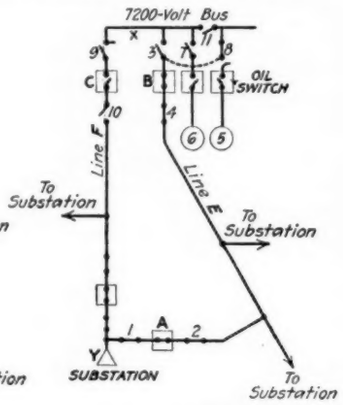


FIG. 2. EMERGENCY CONNECTIONS

Fig. 1 shows a single-wire diagram of a 7200-volt three-phase power system, the power plant of which contained six hydro-electric units. Another line was to be connected to the bus at *X*, between where lines *E* and *F* are connected. It was of the utmost importance to keep these lines alive while the new line was connected. The procedure was as follows:

First, the disconnecting switches 1 and 2 and the oil switch *A* were closed at the substation *Y*, thus connecting lines *E* and *F* together. Next, oil switch *B* was opened and then the disconnecting switches 3 and 4. This left line *E* alive through substation *Y*. The load being light at this period, generators 5 and 6 were shut down, and the generator's disconnecting switches 7 and 8 opened. No. 5 generator's cables were then taken off the disconnecting switches 8, and a temporary connection made between disconnecting switches 3 and 8, as indicated by the dotted line in Fig. 2. Disconnecting switches No. 8 on No. 5 generator oil switch and disconnecting switches No. 4 on line *E* were now closed and then oil switch *B* on line *E* closed, thus feeding line *E* again from the bus directly. The next operation was to open oil switch *C* and disconnecting switches 9 and 10 on line *F*. This left line *F* being supplied through line *E* around through substation *Y*. The last move was to open the bus sectionalizing switches 11, thus making the left-hand end section of the bus dead, as shown in Fig. 2. The new line was now connected at *X*, after which the reverse order of switching was followed to get the system back to normal operation.

Iron Mountain, Mich. L. W. WYSS.

Removing Retaining Wedges and Coils from Induction Motors

We are doing considerable repair work on induction motors and find it very difficult to remove the retaining wedges and coils from the stator slots without damaging them. I would appreciate some suggestions from *Power* readers as to their methods of removing the coils and wedges, especially when the windings have been impregnated with an insulating compound.

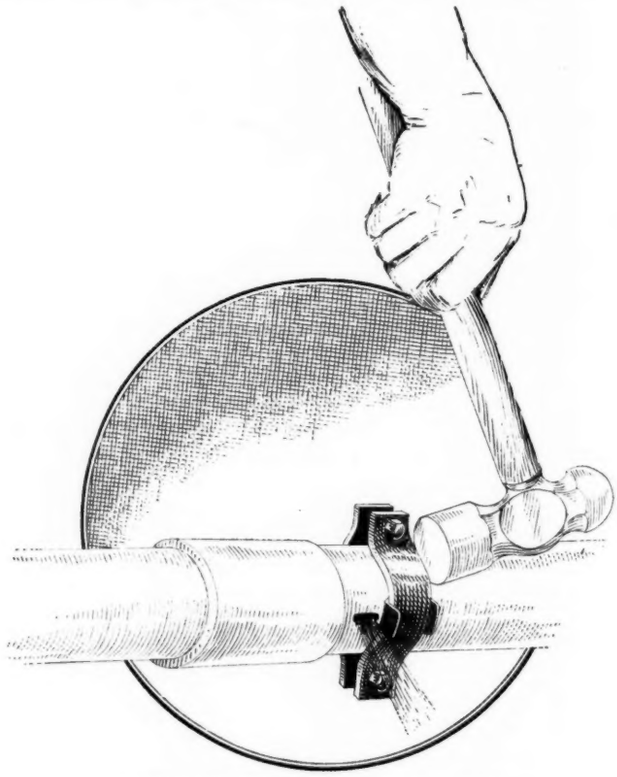
Dubuque, Iowa. W. J. HOHE.

Stopping Leak in Elevator Piping

During the noonday rush of elevator travel in a large office building the 8-in. main pipe that carries the water, under 300 lb. pressure, from the compression tank to the elevator cylinders suddenly began to leak. It was such a mishap as ordinarily puts a hydraulic elevator system out of operation for the time being; but in this case, owing to rapid action by the engineering crew, there was no interruption of the service, notwithstanding the pumps were strained to their utmost to supply the quantity of water that leaked out.

For a part of its length the main traverses the boiler room at the rear end. The leak occurred in this portion, the water issuing laterally from a hole nearly an inch in diameter, that appeared close to a coupling joining two sections of the piping. The colored coal passer, who was standing near-by when the water burst through, grabbed up a short board and undertook to check the flow by placing it over the hole. The instant the stream struck the board, the impact sent him tumbling a distance of twenty feet.

Luckily, there happened to be available a rivet-heating forge, fired up and in service at the time, which was being used in a repair job on one of the boilers. The



HAMMERING THE CLAMP IN PLACE

engineer on watch took two pieces of 2 x ⅝-in. flat iron that were handy and hastily forged them into the form of a band, punching the bolt-holes on the anvil, instead of drilling them, to save time. These were clamped around the pipe, over a liner of sheet copper which was turned up at the edges, and the tightened clamp was driven over the hole with a hammer, as indicated in the sketch. This improvised arrangement held, with considerable leakage, until the close of the day, when the copper liner was taken out and a piece of sheet rubber substituted.

A. J. DIXON.

St. Louis, Mo.

What Should Be the Maximum Length of a Longitudinal Joint in a Boiler?

Referring to the editorial in the July 1 issue on "What Should Be the Maximum Length of a Longitudinal Joint in a Boiler," I would say that when the 12-ft. rule was adopted by the Massachusetts Boiler Rules Committee it was impossible to procure plates rolled any wider than 12 feet. Plates up to 15 ft. wide are now obtainable, therefore the 12-ft. limitation has become out of date.

Any rule should be based not upon some condition of practice, but upon proper principles, and there are cases of construction, such as in the long steam drums of water-tube boilers, where the limitation of length to 12 ft. serves to weaken the construction by reason of the fact that a girth joint is provided in the center of the span of the drum, which involves a construction making the steam drum perform partly the function of a girder and, therefore, full-length course is much stronger and safer.

I understand also that the troubles with former single bottom-plate construction of horizontal return-tubular boilers was not because of the single-length bottom plate itself so much, but because at the time these installations were made plates could not be made wide enough to insure that the riveted longitudinal joints would be away from the direct action of the fire. But with wider plates now obtainable, this difficulty can be avoided and good, serviceable boilers built upon this plan.

I therefore consider that the rule as adopted by the A. S. M. E. Boiler Code Committee is much more suitable than its former rule and more suitable than the rule of the Massachusetts Board.

CHARLES L. HUSTON,
Vice President and Works Manager,
Coatesville, Penn. Lukens Steel Co.

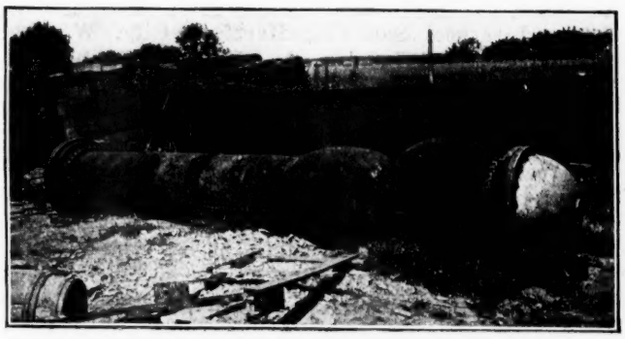
The editorial regarding the length of longitudinal seams is of great interest to all concerned with the operation, construction or insurance of steam boilers. As the editorial states, there should be some common ground in regard to this question that should be considered proper for all boiler rules governing construction.

During the last 20-odd years I have been situated so that I have had exceptional opportunities to investigate boiler accidents. Possibly the experience thus gained in regard to this question may be of interest to the readers of *Power*.

There appears to be no good reason to doubt that the long longitudinal seam of the lap-joint type for horizontal-return-tubular boilers has proved relatively unsafe. That the long longitudinal lap seam is unsafe only on the horizontal-return-tubular type of boiler is to be very much doubted.

The reason that it has obtained such an unsavory reputation in connection with its use on this type of fire-tube boiler is no doubt due to the fact that its use has been confined almost exclusively to such boilers. Long longitudinal seams of the lap type have been used to a considerable extent on a few types of water-tube boilers, and while some failures have occurred, they have not been frequent enough to attract attention. Possibly one of the reasons for the apparent better behavior of these long seams, in the case of the water-tube boiler, is that the diameters of the shells have been relatively small and the structure more rigid on this account.

In figuring the strength of furnaces to resist collapse, the length of sections between supported points is invariably taken into consideration. It has been found by experiment that until this length between supported points exceeds six diameters, it is a factor affecting the strength of the furnace. No doubt the reason that the length between supported points has always been considered a factor in furnace calculations is because the formulas governing such calculations have been derived from experimental data rather than from purely theoretical considerations of the subject. This has not been the case in regard to the calculated strength of boiler seams. That is, while experiments have been made to determine the actual strength of joints, these experiments have been on short sections of joints that could be pulled in a testing machine, and not by the application of a test pressure to a vessel in which the joint to be tested was applied. Invariably, where a test pressure approximating the bursting pressure is applied to a cylinder composed of courses, the material about midway between the girth seams extends more



SHOWING STIFFENING EFFECT OF THE GIRTH JOINT

than at these seams, indicating a stiffening effect by the girth joints. This stiffening effect of the girth joint is well illustrated in the accompanying illustration, which shows an ammonia retort that was used in an ice plant, and under pressure at the time the plant was destroyed by fire.

The same result is to be noted in similar vessels when subjected to a hydrostatic test to destruction, but of course the bulging of the courses between the girth seams is not so pronounced. This would seem to indicate clearly that if two cylinders were of identical proportions, except that one was made up of several courses while the other was constructed of a single course, the former would be the stronger of the two. Most mills cannot roll sheets over 12 ft. in width. To make a joint over 12 ft. in length a sheet that is 12 ft. or less wide must be rolled crosswise of its grain.

An inspector, in recommending the removal of some old long-seam boilers, illustrated the lack of reliability of the metal when used with the maximum stress across the grain rather than with it, by striking a short piece of board across the edge of a work bench so that the bench edge and the grain of the wood were parallel. The board, of course, under this test split in two. A similar piece of board was struck with the edge of the bench at right angles with the grain of the wood, and of course this treatment did not produce any damage to the board. This illustration, while not accurately representing the condition with respect to the boiler plate, proved satisfactory to the owner and resulted

in the much-needed retirement of some obsolete boiler equipment.

This difference in the strength of the plate at right angles to the way it was rolled is cared for in the A. S. M. E. Code requirements by specifying a test of the material in the direction of the greatest stress.

A further fact that seems to demonstrate the strengthening effect of short courses for boilers is that the old two-flue and cylinder types of boilers were practically immune to the defect known as the "lap crack." Such boilers were made in courses generally 24 to 30 inches in length and never more than 42 inches.

That long-seam boilers do frequently explode and with violent results may be seen from the following list of 14 explosions of boilers of this type of construction, which occurred in the decade from 1900 to 1909 inclusive: James Beach & Son, Dubuque, Ia.; Paxton Electric Light Co., Paxton, Ill.; Hayes Manufacturing Co., Erie, Penn.; Penberthy Injector Co., Detroit, Mich.; Park Steel Co., Pittsburgh, Penn.; Hilton Lumber Co.; Central Pennsylvania Light and Power Co.; Taylor Silk Mill, Taylor, Penn.; American Palace Laundry Co., Buffalo, N. Y.; J. N. Russell, Tipton, Ind.; Monongahela City Water Works Co., Monongahela, Penn.; Liverpool Salt Co., Hartford City, W. Va.; Trexler & Tunell Lumber Co., Ricketts, Penn.; and Radcliffe Mills, Shelton, Conn. The property damage that was occasioned by these explosions amounted to about $360,000.

It remains to be demonstrated whether the butt-strap type of construction for longitudinal joints will remedy the defects that have been found to exist with the long-seam construction using the lap type of joint.

The use of long longitudinal seams of the lap-joint type on locomotive or vertical tubular boilers should, in my opinion, show the same results as the use of similar seams on the horizontal-return-tubular type of boiler. Without doubt the reason why disastrous explosions have not been noted with as great frequency on the two former types of boilers is because longitudinal seams exceeding 12 ft. in length have rarely been applied to such boilers.

In the case of lap-seam cracks it is not usual to find that defects in the plate approach the girth seams nearer than 12 to 18 inches. This is another fact which seems to demonstrate the stiffening effect of girth joints which acts to prevent distortion of the shell plates in the vicinity of the girth seams.

S. F. JETER,
Chief Engineer, Hartford Steam Boiler Inspection and Insurance Co.
Hartford, Conn.

Referring to the editorial on the maximum length of longitudinal joints of boilers in the issue of July 1, I have never known why the Massachusetts Rules limit the length of longitudinal joints of certain types of boilers to 12 ft., but have supposed that it is due to the fact that plates are often grooved (or used to be) in the direction of rolling because the steel mills do not (or did not) keep their rolls in good order. As the rolls are used, they wear unevenly and become grooved, and the result is that the plates are grooved. I have inspected a great deal of boiler plate at mills, have observed this, and have found that specimens cut at right angles to the direction of rolling do not show as much elongation as when cut the other way, because this phenomenon is confined to one of the short spaces between ridges. If this defect of plates is sufficient, it is just as bad in one kind of boiler as another and equally bad in steam drums of water-tube boilers. If it were not for this, I can conceive of no objection to as long longitudinal joints as can be made.

I think that boiler rules should permit longitudinal joints of any length provided the plates are not grooved to greater depths than might be prescribed.

It should not be supposed that boiler plates are perceptibly stronger in one direction than in the other because they are apparently rolled in one direction. In fact, they are rolled in both directions, although more in one than in the other. When an ingot is placed between rolls it is rolled sidewise and diagonally until it is sufficiently wide to insure the desired width of the plate, after which it is, of course, rolled lengthwise until it is reduced to the proper thickness. This renders the plate as strong and ductile in one direction as in the other except in so far as grooves localize the latter property.

While I have written as if the grooves are a serious defect, my private opinion is that they are harmless, for boilers do not explode from such a defect as this.

Philadelphia, Penn. F. W. DEAN.

Sodium Bichromate in Ammonia

In a circular sent out June 15, 1918, the United States Food Administration recommended the addition of one-half pound of sodium bichromate to each 100 lb. of aqua ammonia in the charge of an absorption refrigerating machine to prevent the formation of foul gas in the system and corrosion of the pipes and tanks in contact with the aqua ammonia.

I put about thirty pounds of this chemical into the system of the refrigerating plant under my charge and found that it prevented to a great extent the formation of this foul gas; but I would like to see the subject discussed in the columns of *Power* by other engineers who have used the chemical.

On washing out the machines last winter, I found considerable black deposit in the generators, etc., and on taking a sample of it to our chemist for test, he pronounced it iron oxide. We found it necessary to renew approximately 125 lead disks of valves on the generators, weak-liquor coolers, exchangers and other parts of the machine in contact with the aqua ammonia, but practically none where only gas came in contact with the disk. Two coils of our exchanger were corroded through and leaking and had to be cut out of service.

Wherever we have any leaks of hot ammonia, a sticky, whitish substance with a decided bitter, salty taste oozes out of the joint or stuffing-box that may be leaking, and I have not yet determined what this substance is.

We are now experimenting with adding caustic soda to the calcium brine solution to prevent corrosion of the brine piping and tanks. One of our tanks which forms an air chamber to smooth out the pulsations of the brine pumps corroded internally so badly that we had to cut it out of service.

We are looking for something that can be added to the aqua ammonia charge that will prevent entirely the corrosion of the piping and interior of the aqua pumps, etc. I would like to hear, through *Power*, from anyone feeling qualified to discuss the subject.

Brooklyn, N. Y. W. T. MEINZER.

Inquiries of General Interest

Frosting Back of Ice Machine—Is there any advantage in having the suction of an ice machine "frost back" to the machine? W. M. H.

Frosting back occurs because the cooling coils are not absorbing as much heat as they should. The liquid admitted to the cooling coils is not evaporated in those coils but some is carried over and evaporated in the suction line where cooling is not utilized, and the frosting back is of no advantage.

Distance of Pulley Centers for Motor Drive—What is the approximate rule for the minimum distance between pulley centers for open belt drives from small electric motors? H. P. R.

A rule that has given satisfaction with pulleys of usual sizes is that the distance between the pulley centers should not be less than three times the sum of the diameters of the pulleys. A distance of four or five times the sum of diameters will result in a better drive.

Tilting Trap as Water Meter—Could not a tilting trap be used with a counter attached for metering the amount of feed water supplied to a boiler? C. C. G.

The amount of water discharged per cycle of the trap would be irregular unless special means were employed to render the friction of moving parts constant. With ordinary forms of tilting traps, the irregularity of discharge could not be accounted for with sufficient accuracy for testing without making calibrations so frequently as to render their use impractical.

Sufficient Size of Steam Pipe—How can it be known whether the diameter of an engine steam pipe is large enough? E. N.

The pipe should be so large that when the engine is carrying its fullest load, the gage pressure at the boiler side of the engine throttle valve will be not less than 97 per cent. of the gage pressure in the outlet side of the boiler stop valve. With steam pipes of ordinary length such a drop of pressure will not be exceeded, allowing for a velocity of steam in the pipe of 6000 ft. per min., a piston speed of 600 ft. per min. and cross-sectional area of steam pipe of about one third the diameter of the engine cylinder.

Slippage of Riveted Joint of Boiler—Is slippage of a riveted boiler joint an indication that the joint has been stressed to the point of failure? F. M.

In a newly constructed joint the resistance to initial slippage consists mainly of friction between the plates due to the longitudinal shrinkage of the rivets from cooling after they are driven. Some displacement of the plates must occur before the sides of the holes are brought to a bearing to exert a shearing action on the rivets, because the rivets in cooling also contract in diameter and do not completely fill the rivet holes. In American boiler practice the assistance that is rendered by friction between the plates is regarded as uncertain and the strength of riveted joints is based on resistance to stresses concomitant with shearing action on the rivets; and sufficient slippage for taking up bearings on the rivets that have been properly driven is only an indication that the rivets are in position for receiving the shearing stresses, and not that the joint has been stressed to the point of failure.

Obtaining Correct Gage Pressure—We have some low-pressure steam gages located about 10 ft. below the steam lines, that indicate about 5 lb. above the pressure of the steam. How can the gages be connected to show the correct pressure? E. W.

When a correct gage is placed below the pipe, the pressure indicated will be the pressure in the pipe plus the pressure due to the height of water column in the connection, measured from the bottom of the steam main to the center of the gage. Assuming that the temperature and density of the water in the connecting pipe are constant, the plus quantity will be the same for all pressures and the pressure indicated when there is only atmospheric pressure in the steam pipe and with the gage pipe filled with water will be the amount to be deducted from all reading to obtain the gage pressure in the steam pipe. If it is desired to obtain correct readings at sight, without making the subtraction, reset the gage pointer or supply the gage with an extra pointer, to indicate zero on the dial when the connection is filled with water and the gage pressure in the steam pipe is 0.

Keeping Motor in Service—How can a shunt- or compound-wound motor be started and kept in service if the starting box burned out? E. P.

The connections for starting a shunt and a compound motor with a water rheostat are shown in Figs. 1 and 2

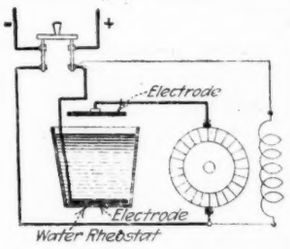


FIG. 1. CONNECTIONS FOR STARTING SHUNT MOTOR WITH WATER RHEOSTAT

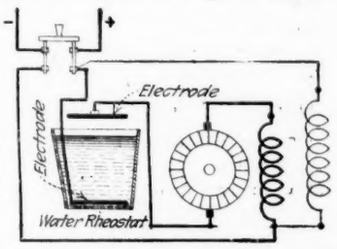


FIG. 2. CONNECTIONS FOR STARTING COMPOUND MOTOR WITH WATER RHEOSTAT

respectively. The water rheostat is made from a bucket of water with a handful of common salt in it. It is preferable that a wooden bucket be used. One metal electrode is placed in the bottom of the bucket, and the other is gradually lowered into the solution at starting until the two electrodes are together. When the motor is shut down, care should be exercised to see that the top electrode is removed from the bucket, or the fuses will be blown if the switch is closed with the electrodes together.

Scale of Indicator Diagram for Reduced Size of Piston—When indicators are quoted as having one-half or one-fourth size pistons, are the fractions intended to signify inches of diameter or relative areas; and when the smaller pistons are used, how is the scale value of the diagrams determined when the indicator is employed with a standard scale of spring? G. L.

Some indicators are made to receive pistons of smaller area than the regular or standard area of piston, by elongating the piston rod enough for a smaller piston to reach down and work in a part of the cylinder where the bore is one-half of one-fourth of the cross-sectional area of the standard piston. By reason of resisting pressure exerted on only one-half or one-fourth of the standard area, the effective scale of the spring thereby becomes twice or four times as great. Thus the scale of a diagram made with a spring whose scale is 40 lb., when used with the standard piston would be 2×40, or 80 lb. per sq.in. per inch rise of the pencil when used with a one-half size piston; and a 60-lb. spring used with a one-fourth piston would produce a diagram whose pressure scale per inch rise of the pencil would be 4×60, or 240 lb. per square inch.

The Corrosion of Metals*

By GUY D. BENGOUGH, M.A., B.Sc., and O. F. HUDSON, A.R.C.S., D.Sc.

THE report is divided into three main parts. The first is devoted to the question of the nature of the actions that take place when metals such as zinc, copper, aluminum, and alloys such as 70:30 brass, corrode in neutral or nearly neutral liquids, for example, distilled water and sea-water. The second section is devoted to the consideration of the behavior of condenser tubes in similar liquids, and the variations in behavior in different samples of tubes of nominally the same composition. In the third section an attempt is made to set out in some detail a statement of the practical problems of corrosion, which appear to the authors to be very different from what is usually supposed. A preliminary account is also given of experiments carried out with the object of testing an electrolytic (the Cumberland) process of protection. A preoxidizing protection process is briefly described.

Part I. The Nature of Corrosive Action

The current theories of corrosion are briefly considered. The difficulties in the way of making a true quantitative determination of the amount of corrosion are discussed and shown to be almost insoluble in certain cases with existing methods of analysis. Mere "loss of weight" measurements, unsupported by detailed analyses of scale and metals in solution, are considered to be of little value in many cases, and might be replaced with advantage by microscopic work.

The action of distilled water on metallic zinc has been studied in some detail, and the following conclusions have been reached. Metallic zinc is normally covered with a partially protective scale, which consists largely of oxide or basic carbonate. Water containing CO_2 can attack or dissolve the oxidized layer, and zinc can then be found in solution as a slightly soluble bicarbonate. The attack on the scale begins at certain points, and a true metallic surface is exposed to the action of the water. At such places a peculiar form of oxide is formed on the surface of the metal. Probably this oxide contains zinc peroxide and exerts a catalytic action on the underlying metal. It is slightly soluble and passes into solution, and is afterward largely precipitated as the ordinary hydroxide and carbonate. The precipitated hydroxide has a distinctly protective action on the metal beneath it and reinforces the original scale and enables it to resist the action of CO_2. The action is thus localized. In the presence of very large amounts of CO_2, as, for instance, when the water is kept saturated by bubbling CO_2 through it, the products of corrosion are largely kept in solution and local action is almost entirely avoided, though the total amount of corrosion that takes place is increased. This is due to the fact that almost the whole of the original scale is removed by the solvent action of the water, with the result that further oxidation of the metal can take place, and further solution.

In the case of very dilute acid, such as acetic, the action consists in the replacement of hydrogen by zinc, but the action is not severely localized as in the case of distilled water; there are no local accumulations of the products of corrosion, and consequently the action is much more nearly uniform. There is no evidence that dissolved oxygen can act as a depolarizer; hydrogen is given off as gas. The authors come to the conclusion that the initial action of distilled water on zinc is a process of chemical oxidation rather than electrochemical displacement. The action of sea-water on zinc is also chemical rather than electrochemical and local action in this case also is due to the local accumulation of certain products of corrosion. The action of distilled water on copper is also chemical oxidation. There is no preliminary electrolytic action, even in the case of a surface of metallic copper known to be free from oxide previous to immersion. The oxide formed over the general surface immediately after immersion is a lower oxide, either Cu_4O or Cu_2O. In course of time it becomes further oxidized at irregularly distributed spots, and the product thus formed does not protect the underlying metal from oxidation to the same extent as does the original tarnish layer. The dark oxidation product itself, which is probably a cupric hydroxide or basic carbonate, tends to flake off the metal, probably owing to the formation of bulky oxidation products beneath it. The latter are porous, and apparently amorphous, and probably act catalytically by increasing the rate of oxidation of the underlying metal.

The amorphous oxide is slightly soluble, but is finally precipitated from solution as crystalline cuprite, which has a lower solubility than the amorphous oxide. The result of the action, continued in time, is to cause shallow pits in the metal. Such pits are much less important than in the case of zinc. In the case of some further experiments, however, this pitting action was not developed, and the

CAUSES OF CONDENSER TUBE AND FERRULE CORROSION (WATER SIDE ONLY CONSIDERED)

Cause	How Produced	Nature of Action	How to Be Remedied
A. Foreign bodies carried in and accumulation of products	A1. By ferric hydrate flakes from water ends A2. By ashes, clinkers, etc. A3. By sludge of sorts in water supply	Complete corrosion of the oxide disintegration type, causing local action	A1. Paint the pipe line and water ends Increase water speed A1, A2 and A3. If worth while trap the water supply or pass it through a screen. In some cases increase water speed
B. Acid or other bad or variable water supply	B1. Some river supplies, for example Tyne, B2. Some canal supplies, for example, ship canal B3. Some well supplies B4. Some estuarine supplies B5. Some cooling-tower arrangements	Complete corrosion and rapid general chinning. Sometimes slight uniform dezinicification	Keep water supply slightly alkaline Use special tubes adapted to the special conditions
C. Temperature in condenser too high	C1. Hot inlet water, for example, tropical C2. Slow water speed C3. Partial blocking of tubes	C1. Denzincification C2. Denzincification C3. See A3	C1 and C2. Use special tubes C2. Increase speed C3. See A3
D. Undue aeration	D1. Errors in pump and pipe line arrangements D2. Eddies near inlet causing water-line effect	D1. Complete corrosion of oxide disintegration type D2. Complete corrosion of pitted areas	D1. Remedy air leaks, etc. D2. Special ferrules. Possibly increasing speed of water with modified design of water end
E. Unsuitable composition of tube	E1. Zinc or impurities in too great amount E2. Surface of tube not sufficiently copper-rich	E1. Varies E2. Dezincification	E1. In manufacturing E2. Probably by attention to details of annealing and pickling during manufacture
F. Defective packing of tubes	F1. Leaks caused by perishing of the packing material especially in acid water F2. Collapsing of tube	F1. Varies F2. Varies	F1. Use good tape packing. Red lead is sometimes useful to prevent leakage F2. Do not crush tube when inserting it
G. Physically bad surface of tube; such as bad spills and laminations	G1. Foreign bodies caught and trapped which would otherwise be swept away	G1. Complete corrosion and oxide disintegration	G1. During manufacture
H. Theromo-electric action in condenser	H. By steam impinging directly on tubes, or being improperly distributed	H. Denzincification	H1. Only occures in condensers of old design when steam is not properly distributed
I. Too slow water speed	I. Gases given off inside tube and not immediately swept away	I. Complete corrosion near inlet end	I. Increase speed of water. Do not use main condenser for auxiliary machinery import

*Fourth report of the Corrosion Committee of the Institute of Metals. General summary forming conclusion of paper read before the Institute of Metals on Mar. 25. The report itself extends to so great a length that it is not possible to publish it *in extenso*.

only action that could be observed was the formation of thick layers of oxide over the whole surface of the metal. These layers do not necessarily remain of uniform thickness over the whole surface of the specimen, but pronounced local action does not occur. In rare cases appearances are found on metallic copper, which the authors have only been able to interpret on the assumption that they are little electrolytic cells,[1] but the phenomenon is so rare that it is unimportant in comparison with the main action already described.

The principal action of sea-water on copper is again one of chemical oxidation. The action may be localized by the accumulation of products of corrosion, under certain conditions.

It has been found that the aëration of one of a pair of copper electrodes causes that electrode to be slightly electropositive to the other. The effect on the rate of corrosion of the em.f. so set up was, however, found to be quite small and less than the effect of other physical factors, such as the rate of flow of the corroding medium and the degree of aëration. The conclusion has been formed that differences in the rate of oxidation have a greater effect on the amount of corrosion than small differences of potential.

A number of experiments have been made on the effect of coupling together electrodes of different metals, and immersing them in different electrolytes. The behavior of such couples was by no means always such as would be expected from electrode potential lists. In some cases the couple behaved in the reverse way to that which was expected, and in others the effect of the couple in increasing corrosion was much less than expected. The effect of a couple is greatly decreased if the contact between the electrodes is not very carefully made. It is probable that the effect of couples in some of the practical problems of corrosion has been over-emphasized rather than the opposite, as sufficiently good contact for large effect does not usually occur. It has been definitely established that a metal may be oxidized and pass into solution in spite of the fact that it has been continuously maintained as a cathode, and the laboratory result has been confirmed on the practical scale by experiments carried out with an electrolytic protection of condenser tubes (the Cumberland process).

A preliminary study of aluminum and certain light alloys in distilled water and sea-water has been carried out. Local severe pitting at or near the water-line is described and discussed. It is shown to be due to the presence of a strongly acid salt.

An attempt is made to introduce a definite system of nomenclature into the terms used in the study of the corrosion of binary alloys, in order to avoid the confusion which at present obtains. In certain cases precise definitions cannot be formulated, as in the case 70:30 brass, owing to the difficulty of distinguishing between residual metal and redeposited metal.

The nature of the action of distilled water on 70:30 brass has been studied in detail by means of the microscope and analytical methods. The action is considered to be the chemical oxidation of the copper and zinc, and the partial solution of the oxidized products. Much of the zinc passes into solution, in the presence of CO_2 and part of the copper, the remainder of both metals remaining on the surface of the alloy as an oxide scale. The scale becomes further oxidized and altered at certain spots which become covered with thick deposits of the products of attack. Such deposits are porous and allow, and probably accelerate, local attack on the underlying metal. The attack is accompanied by redeposition of copper by displacement by the zinc either electrochemically or otherwise, and precipitation of cuprite. There are signs of slight local dezincification at such places, but the attack over the general surface of the alloy is complete corrosion. The positions at which local attack and pitting take place are not determined by the variation in the electrical properties of the original metal, but by the conditions of the experiment. In the presence of dilute acids, such as HCl and H_2SO_4, local action of the type described does not occur, since there is little or no local accumulation of oxidation products. On the other hand, the absence of CO_2 retards the action. From the analytical data it appeared that the local action in the case of distilled water increased with time, while the rate of general corrosion over the whole specimen fell off. These facts suggest the fallacy of loss of weight tests, since local action is more important practically than general corrosion.

The action of sea-water on brass has been studied on the same lines as that of distilled water. The action is considered to be similar in type. Local pitting and dezincification are due to the accumulation of the products of corrosion. Under certain conditions redeposition of copper may occur. The rate of general corrosion is much greater than that in distilled water, and does not fall off so rapidly with time. At the ordinary temperature there is less tendency to local dezincification.

Part II. The Corrosion and Protection of Condenser Tubes

The form of the surface of certain condenser tubes of 70:30 brass has been studied in detail. The presence of a layer that differs in its behavior toward corrosive agents from the underlying metal has been identified in several different ways. In many cases this layer is probably richer in copper than the alloy beneath it. In such cases the tube may resist dezincification in a marked degree for long periods; in other cases the surface layer probably has nearly the same composition as the rest of the tube, and in such cases strong dezincification may take place in sea-water in the neighborhood of 50 deg. C. Tubes from the same batch of manufacture usually resemble one another as regards the nature and properties of the layer, and tubes from different batches, even though made by the same maker, may differ. Thus one important factor as regards dezincification is the nature of the tube, but the kind of surface that best resists dezincification does not necessarily best resist other kinds of attack. Means of controlling the surface layer have not yet been worked out, but the problem does not appear to be insuperable and is receiving attention. The condition of the surface layer should be adapted to the conditions under which the tube will be used.

In many cases local action may be initiated on condenser tubes by the action of certain bodies, which themselves appear to take no direct part in the action. Such bodies are sand, calcium carbonate, ferric hydrate, glass, clinker and coke. The amount of action that takes place varies with the physical properties of the substance. The action is associated with the accumulation of products of corrosion and may be largely assisted by them. The nature of this action is of well-marked type, and has been provisionally called oxide disintegration. It is usually characterized by intercrystalline oxidation. Actions of this kind are of great importance in many cases of corrosion on the practical scale.

A preliminary study has been made of the action of very dilute acids on copper, 70:30 brass, and Admiralty alloy. The matter is important technically, because supplies of water in certain parts of the country are slightly acid in character. The strengths of acids used were between 5 and 10 parts of acid in 100,000 of water. Both HCl and H_2SO_4 were used. Acids of these strengths greatly accelerate corrosion and alter the type of action. The attack of the two acids, even when of equivalent strength, differs both in extent and character, that of HCl being greater and more selective. Admiralty condenser tube was decidedly more resistant than 70:30 brass to the action of dilute acids.

Part III. Notes on Practical Problems of Corrosion

Part III of the Report deals with the subject of corrosion under practical conditions as it appears to the authors. The views expressed are founded upon their general experience both in the laboratory and in connection with working conditions of actual plants. Unfortunately, the conditions in a practical plant are never known in full detail. Evidence as to the cause or causes of corrosion usually rests on a comparison of the corroded tube with others which appear to be similarly attacked under conditions that are more

[1] These appearances are only found after oxidation to dark oxide, etc., and not in the earlier stages of corrosion.

precisely known.[2] The degree of probability, therefore, which attaches to these views must be regarded as lower than that based on conclusions drawn from laboratory experiments.

The authors express the view that corrosive attack on condenser tubes is more diverse in character and complicated in nature than has been generally supposed. The first action is one of chemical oxidation, and secondary actions are of great importance. No one single remedy is likely to be found effective for all the different kinds of attack which occur in practice. The nature of the tube used and the protective measures chosen should be dependent on the particular set of conditions.

The following is a set of conditions under which a 70:30 brass condenser tube should have a minimum life of 20 years:

a. Only clear water to enter the tube, or water which will not deposit suspended matter.

b. The water must be free from gases in suspension, and must not contain more than the normal amount of air in solution.

c. The water must be neutral or not more than very slightly alkaline. It must be free from ammonia and certain other specially harmful substances, which are, however, comparatively rare.

d. The temperature of the cooling water in the hottest part of the condenser should not exceed 35 deg. C.

e. The speed of the water should be about 5 or 6 ft. per sec.

f. The steam should be properly distributed in the condenser, according to the best modern practice.

A water supply which varies considerably in composition at different times of the year involves special problems and must therefore be excluded from the above statement at present.

In practice tubes fail sooner than the period stated, because the normal slow roughening of the tube by chemical oxidation is locally speeded up by factors which are for the most part independent of the tube. It will be noticed that this way of treating the subject is the inverse of that usually adopted. A preliminary attempt is made to gather the more important of these factors into a tabular statement, given on a preceding page. The statement is to be regarded as a skeleton structure, which will be amended and filled in as experience accumulates.

In practice factors set out separately in the table may act jointly. Causes of corrosion are not arranged in the table in order of importance, since the order varies in different types of installation. The effect of water speed on the rate of corrosion is briefly discussed; its effect varies with the type of corrosion.

The effect of the presence of a scale on the rate of corrosion is considered to be of great importance. Of the substances that commonly occur in scale, calcium carbonate is one of the most important. Its effect varies with its physical condition. It may exert almost any kind of effect from a considerable degree of protection to a serious attack.

Some observations are described on the effect of a form of electrolytic protection (the Cumberland process) at the Southwick Power Station of the Brighton Corporation, which is under the charge of J. Christie, who has placed many facilities at the authors' disposal. The conclusion is reached that the process insures a prolonged life for the tubes under Southwick conditions, provided that it is applied to new tubes, that is, to tubes that have not begun to corrode before the process is in operation. The process should be applied continuously and not intermittently. The authors consider that the thin uniform scale that is maintained on the tubes by the process is an important factor in preventing serious corrosion. One of the important functions of the scale is to prevent contact between the tube and harmful deposits and products of corrosion; in addition it slows down, but does not entirely prevent, the general oxidation of the tube. The authors consider that further evidence is necessary before the value of the process can be estimated as regards prevention of corrosion in certain types of water other than ordinary sea-water, and in the presence of deposits other than those which occur at Southwick. Other possible methods of protection are briefly considered, and a preliminary account is given of a preoxidizing process for reducing the rate of corrosion.

[2]Much of the evidence cannot be satisfactorily reproduced either photographically or by any other other means known to the author. It is obtainable only by personal examination of tubes.

American Institute of Electrical Engineers Proposes Changes in its Activities

At the annual convention of the American Institute of Electrical Engineers held at Lake Placid Club, June 24-27, 1919, three sessions were devoted to a discussion of the changes in the institute's *Proceedings* and other activities as proposed by the development committee. The changes proposed by the committee are given in the following:

I. Publication

(a) Entirely change the character and form of the monthly publication by adopting the so-called standard technical publication size (9 x 12 in.), enlarging the editorial and executive publication staff, and make every effort to develop this publication into the best possible engineering magazine without in any way lowering the institute's standards.

(b) Eliminate therefrom the publication of papers except institute and occasional papers of unusual broad general interest or value. Substitute a set of abstracts of perhaps one-half page each of every paper presented to every section so that each month there will be a complete record of this class of institute activity.

(c) (New clause.) Print the *Proceedings* in two sections bound together into one publication when issued, but so arranged that they may be later separated by the recipient who may wish to dispense with that part made up of temporary matter and retain that part containing matter of permanent value. Publish in later issues of the *Proceedings* all discussions of papers previously appearing in full.

Note. The cost of printing, binding and distributing *Annual Transactions* now averages $18,000. It is thought that this amount of money can be expended with better results to the membership if the above plan will be acceptable to the membership in lieu of the present practice.

(d) Substitute for (c): Create a special committee which, after a definite general publication policy shall have been adopted, shall study all questions concerning the publication, free distribution, sale, etc., of papers not printed in the *Proceedings*.

(e) Formerly (d): Employ as a part of the magazine staff the best advertising solicitors obtainable and endeavor to make the publication a large earner. With the example of the American Society of Mechanical Engineers and the National Geographic Society before us, it is believed that a substantial profit can in time be realized by this means, and if so, it is proposed to allocate a liberal part of such profit pro rata to the various sections.

II. Organizations

(a) Create a New York section, to be organized and conducted on the same lines as existing sections elsewhere.

(b) Discontinue holding monthly institute meetings in New York and inaugurate the policy of holding institute and directors' meetings successively in different parts of the country where local sections are established. It may be desirable to reduce the frequency of institute and directors' meetings and hold them every two months or perhaps even less frequently instead of every month as now.

(c) Divide the country into geographical divisions corresponding in number to the number of institute vice presidents. If more than six divisions should be thought desirable, they should be established and the number of vice presidents increased to correspond. In order to allow for the future shifting of membership density and at the same time to escape the necessity of cumbersome constitutional amendments, the number and delimitation of geographical divisions should be specified in the by-laws instead of the constitution, to provide for ready amendment by the board of directors.

(d) Select one vice president from each geographical division. Continue to elect the president and managers from the membership at large as at present.

Note. The legaltity of electing directors to an organization chartered under the New York State law in any other

way than by the vote of the entire membership is being investigated by counsel.

(e) Pay the traveling and living expenses of the officers and board members when attending institute meetings. It is hoped that by the payment of these expenses and by a reduction in the number of institute meetings held each year a full attendance can be secured and all parts of the country be better represented.

(f) Make it the duty of each vice president to visit the sections in his own division at least once a year. Of course, it would also be desirable if the vice presidents could exchange visits.

(g) (New section.) Increase the vice presidents' term of office from one year to two years and remove the constitutional inhibition against the election of a vice president as manager. Provide against perpetual tenure of office by a constitutional provision that, except in the case of a manager or a vice president who may be elected president, no member may continuously hold office longer than for six years.

III. Activities

(a) Decentralize committee work as far as it may be found feasible and desirable by substituting section committees for institute committees. Appoint a general committee to study this question and make recommendations.

(b) Present more high-grade papers of general engineering interest.

Note. The clause as originally worded gave the impression that the standard of the institute papers was to be lowered instead of broadened.

(c) Create a committee in each section charged with the duty of assigning to the younger members specific participation in designated meetings by the preparation of papers, discussion or otherwise. It is hoped by this means and by the appointment of a reasonable number of the younger men to the larger committee membership caused by decentralization that the interest of the younger men will be stimulated and their loyalty increased.

IV. Local Federation

(a) Prepare a comprehensive but flexible uniform outline for the federation of local engineering bodies, taking advantage of the experience already gained by existing affiliations.

(b) Use our endeavors to have the other national societies establish and support local sections along lines similar to ours, but do not confine local federations to such branches, rather planning to include all the worthy engineering bodies.

(c) Wherever such federation can be organized, establish under an appropriate name a federated local council of engineers to be made up of a properly apportioned number of representatives from the different locals.

V. National Council

(a) Establish a direct touch between each local federated council and a National Engineering Council composed of delegates from as many national engineering societies as are willing and worthy to participate.

(b) Through the medium of the national and the local federated councils perfect a working arrangement for engineering coöperation in all public affairs where such is desirable.

VI. Engineering Congress

Endeavor to inaugurate the custom of periodically holding an engineering congress, the delegates to which should be selected from all parts of the country under a plan to be developed for suitable representation, this congress to consider and take action on such matters of general interest to engineers and to the public as may merit its attention and as have been previously advertised for a sufficient length of time to permit locals everywhere to give them consideration and when possible to send instructed delegates.

Note. Many suggestions have been offered regarding the details to be considered in carrying out the plan outlined in Sections IV, V and VI, but inasmuch as progress can be made only by and with the coöperation of the other founder societies, it has been thought best not to attempt to specify details in our recommendations, but having expressed approval of the general plan outlined, to leave the working out of such details to our conferees.

It is estimated by French engineers that it will take ten years to restore completely the production rate of the mines destroyed by the Germans in northern France. In one mine alone, there is 20,000,000 cu.m. of water due to destroyed shaft linings and to that ditched in from surface ponds.

Swedish Developments in the Use of Electric Power

A bulletin issued by the Guaranty Trust Co., of New York, states that probably in no other country in the world, with the possible exception of the neighboring state of Norway, is there more intensive development in progress in the utilization of electrical energy than in Sweden.

There is in Sweden a remarkable tendency to apply the use of such power to every phase of the economic life of the country—to industry, to public utilities, to state and privately owned railroads, to agriculture and to home life in remote districts as well as in the cities. The importance of the development is out of all proportion to population.

Sweden possesses some coal, but it is not of the highest quality and the supply is inadequate for domestic needs. Her immense forests are her greatest present source of national income, but the day has passed when wood fuel can be broadly and economically employed. War markets afforded great incentive to the expansion of old and new industries, yet the difficulty and cost of importing raw materials, especially coal, created a handicap that would have been insurmountable but for the driving power at hand in the Swedish lakes and streams.

Great strides in water-power development were made during the war, and greater developments are planned. There is no desire to repeat the war experience of running her railroads on wood, 40,000,000 cu.m. of which was consumed in 1917, or upon imported coal at 175 crowns ($46.90) per ton, the price in October, 1918. Power, comparatively cheap, abundant, and available with little regard to conditions abroad, will assist immensely in realizing the industrial and commercial possiblities of her future.

The amount of water power normally available in Sweden may be conservatively set at 5,000,000 hp. Such a figure places her above any other country in Europe in this respect, with the exception of Norway. Water power has been used in her industries for centuries, and before the outbreak of war produced more than half the mechanical power in the country, the total consumption exceeding a million horsepower.

Heretofore, Sweden has paid heavy toll to Germany for her lack of direct shipping connections with outlying countries. Plans now being formulated will bring Swedish ports into direct and regular communication with this country, and the new policy of her big men is predicated upon the cultivation of closer commercial and financial relations with the United States.

Prior to the war our part in supplying electrical equipment to Sweden was almost nil. It is only in the past two years that our share has grown appreciably and it would appear to be entirely up to the American exporter of these commodities whether the figures rise to new heights or fall back to their old level. In 1917 our total exports of electrical goods amounted to $155,949.

It has been announced that Dwight P. Robinson & Co., Inc., 61 Broadway, New York City, have been awarded a contract by the Duquesne Lighting Co., of Pittsburgh, to design and construct a power station at Cheswick, near Pittsburgh, to have an ultimate capacity of 300,000 kw., of which one unit of 60,000 kw. is to be installed initially. The work consists of a new power-station building with the necessary complement of boilers, piping, electrical apparatus, coal-handling devices, coal storage, etc. It is anticipated that the work of installing the first unit will require about twelve months.

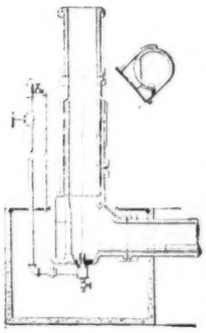
The Kentucky and West Virginia Power Co., with main offices in Philadelphia, has incorporated at Hazard, Ky., with a capitalization of $6,000,000. The company takes over the Kentucky River Power Co., of Hazard, the Tug River Electric Co., of Spriggs, W. Va., and the Logan County Light and Power Co., of Logan, W. Va. The total cost of this purchased property was approximately $2,500,000.

Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

Conveyor, Improved Girtanner Ash

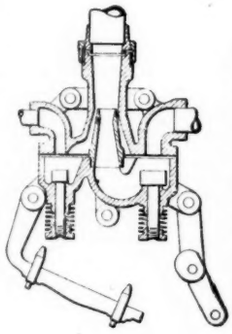
Girtanner Engineering Corporation, 1400 Broadway, New York City. "Power," July 1, 1919



Improvements in this system are: Intake opening 50 per cent. greater area than the pipe; horizontal pipe made in 18-, 24-, 30-, 36-, 48-, 60- and 72-in. standard lengths; pipe joints made tight by means of ¼-in. round asbestos gasket fitting in diamond-shaped grooves cast in face of the flange; ash-intake members designed 36 in. long with the intake opening 3 in. out of center; cover plate also made with opening out of center; turning each end for end to permit of any adjustment within 1 in. at any part of 6 ft.; the bottom of the horizontal pipe is reinforced by liners 18 and 24 in. long; a special horizontal-vertical elbow, fitted with a target plate, can be removed without disturbing the rest of the piping and is fitted with a steam nozzle that can be removed through an opening without breaking the steam-pipe connection.

Discharger, Emergency

Emergency Devices Corp., 108-110 West 34th St., New York City. "Power"



This emergency discharger is designed to control the removal from containers of dangerous liquid, gases, etc., in case of accident, from one or more remote safety stations. It is an ejector with two inlets, one for ammonia and one for water, both of which are controlled by valves, closing on their respective seats by screws carried in a swinging yoke that is held closed by a latch. Pulling on a wire cable attached to the trigger on the valve causes the latch to trip, allowing the yoke to swing back and release the valve. The pressure of water and ammonia and the action of the springs open the valves and permit the liquids to combine and pass through the injector, which discharges through a pipe connection to a convenient point.

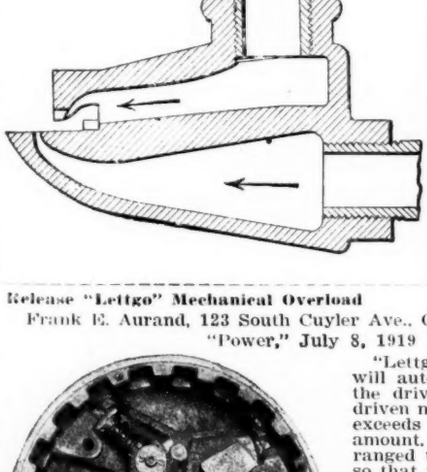
Circuit-Breaker, New Type of Reclosing

Automatic Reclosing Circuit-Breaker Co., Columbus, Ohio. "Power," June 24, 1919

An electromagnetically operated circuit-breaker built in 3000- and 4000-amp. capacity. It is closed and held closed by an electro magnet, and opens automatically in case of overload, short-circuit or voltage failure, and remains open a definite time interval regardless of the cause of opening. The main contact brush is protected from arcing by an auxiliary copper contact shunt, and its final arc is taken care of on the upper graphalloy contact lips. Is adapted for heavy work such as steel mill and railway service.

Burner, Fan Tail, Fuel Oil

John Foerst & Sons, Bayonne, N. J. "Power"



Constructed so as to eliminate wearable parts, stuffing-boxes and regulating cocks, and the arrangement of the stream-controlling surface prevents any possibility of the flame shooting upward against the boiler tube, and produces a fan-shaped flame. The advantages are: Great evaporating power, reasonable cost, easy to install, cannot clog or leak, simple and durable and no adjustment of fuel or air valves every few minutes.

Gear Box, Riley Two-Speed

Sanford Riley Co., Worcester, Mass. "Power," July 1, 1919

The Riley two-speed gear box contains in addition to the worm gearing a double set of spur gears so arranged that by shifting a lever from the high to the low position or vice versa the coal speed is increased or decreased. With this device an over-all range of speed of 4 to 1 is obtained. A simple throw of the shifter lever from left to right cuts the coal supply in half. This is done without changing the speed of the motor. The device is so constructed that it may be applied to any type of Riley stoker.

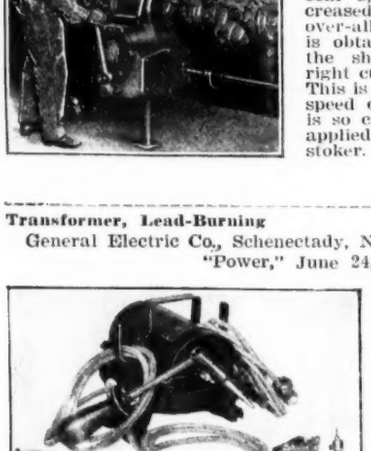
Release "Lettgo" Mechanical Overload

Frank E. Aurand, 123 South Cuyler Ave., Oak Park, Ill. "Power," July 8, 1919

"Lettgo" is a device that will automatically disengage the driving power from the driven machinery, if the load exceeds a predetermined amount. The springs are arranged to adjust the tension so that the release will operate at the proper load and maintain a proper factor of safety. The mechanism is inclosed so that it can be packed with grease for lubricating. The triggers pivotally mounted on a link with the ends engaging inside notches in the rim of the drum and roller form the driving element. When the drive is overstrained, the compression of the springs will permit the ends of the trigger to drop into the release position, and the driving machinery immediately stops.

Transformer, Lead-Burning

General Electric Co., Schenectady, N. Y. "Power," June 24, 1919



This transformer is designed for burning terminals in place on storage batteries, etc. It is connected to the ordinary 110-volt alternating-current lamp sockets, a 10-ft. cord and plug being provided for this purpose. Two separate rubber-covered terminal leads are used to convey the low-voltage heat-producing current to the part of the battery to be welded. When the pointed arc-welding carbon is brought into contact with the lead, the pointed end becomes so hot that it melts the lead over a restricted area quicker than a pointed gas flame will.

Chain Grate, the Coking Coal

Green Engineering Co., East Chicago, Ind. "Power," July 1, 1919

This stoker is provided with a horizontal bedplate, over which coal is pushed into the furnace, an inclined adjustable bedplate directly below this and an oscillating plate below the adjustable bedplate. Fuel is pushed from the stoker hopper by a pusher that is divided into sections having variable stroke mechanisms, so that the amount of fuel fed to any section of the grate is independently controlled.

Patented Aug. 20, 1918

Some Factors in Boiler Practice*

By F. A. COMBE
Engineer for Canada, Babcock & Wilcox Co., Ltd.

There is little difference in temperature of the water throughout any part of a well-designed water-tube boiler, the circulation being caused by a pumping action set up by the steam bubbles, in a similar manner to an air-lift pump, either in the front tubes of a vertically inclined tube boiler, or in the uptake headers of a sectional horizontally inclined tube boiler, and, as with an air lift pump, the rapidity and efficiency of the pumping action is dependent on the avoidance of large chambers in the water passages in which eddies and down currents impede the pumping action. Tests recently carried out on a horizontally inclined tube boiler of the header construction, 28 tubes high, showed that this pumping action amounted to the equivalent of some 18 in. of water head when the boiler was operating at rated capacity and that it increased progressively as the load increased.

The amount of heat absorbed by the surface of the tubes directly exposed to radiant heat from the furnace is generally proportional to the difference of the fourth powers of the absolute temperatures of the two surfaces, or $= C(T^4-t^4)$ where C is a constant for any unit of surface and time. The laws governing radiant heat or heat rays are analogous to those for light, the heat transfer being extremely rapid, but the great proportion of the heat energy is supplied by the obscure or dark rays.

In a Babcock & Wilcox boiler the amount of water evaporated per hour per square foot of surface of the lower rows of tubes exposed to furnace radiation, with a furnace temperature around 2500 deg. F. is at least from 50 to 65 lb., and as this may represent over one-half the total evaporation of the boiler at normal rating, the importance of a full knowledge of the subject of radiation is evident, while it incidentally shows how high the evaporative capacity of a tube is, and that an average evaporation rate of 3½ lb. per square foot heating surface for the whole boiler gives no indication of the amount of work any part of the heating surface is doing.

With a standard setting of boiler designed for 10 sq.ft. of heating surface per boiler horsepower, or an equivalent normal full load evaporation of 3½ lb. per square foot heating surface, and a ratio of heating surface to grate of about 50 to 1, the maximum combined efficiency will usually be maintained fairly constant from 90 to 130 per cent. rating. Below 90 per cent. rating the loss in efficiency is chiefly due to incomplete combustion in the furnace and grate and above 130 per cent. rating chiefly due to the increasing exit-gas temperature, the furnace and grate having then reached their highest efficiency. For other proportions and designs of boiler and furnace the point of maximum efficiency will be different.

Not many years ago the ratio of cubic feet of furnace volume to square foot of grate usually provided was 3 or 3½ to 1, whereas today we may have 5½ or 6½ to 1 for natural-draft stokers and even more for forced-draft stokers, particularly when high overloads are demanded. In the Detroit Edison boilers the ratio is about 9 to 1.

The best method of passing the gases over the tubes, and the relative advantage of different form of baffling have been discussed at various times, but it seems reasonable that a cross-flow over several passes of staggered tubes avoids stratification by insuring the most thorough breaking up of the gas currents, with the consequently better contact of all particles with the walls of the tubes, while with the first pass at the upper end of the tubes, a contra-flow action to the circulation of the water in the boiler is obtained and, at the same time, with a horizontally inclined tube boiler, the circulation will be improved and the danger of blistering the lower row of tubes lessened by procuring quick release from tubes of steam bubbles formed.

In a paper read before the British Institute of Civil Engineers about a year ago, details are given of a test made on a B. & W. cross-drum boiler with integral economizers containing 4963 sq.ft. boiler-heating surface and 4086 sq.ft. economizer surface, in which a thermal efficiency of 88.33 per cent. for the unit was obtained, the exit-gas temperature being 293 deg. F., and the evaporation per square foot boiler-heating surface 9.53; while another test made in 1916 at the Hague municipal plant with a slightly smaller unit gave an over-all efficiency of 88.41 per cent. It is probably not possible to obtain such efficiencies with the coals usually obtainable here, but it indicates that a very high efficiency in steam-generating equipment has been reached.

*Excerpts from a paper before the Engineering Institute of Canada.

New Publications

ANALYSIS OF BABBITT. By James Brakes. Published by Allen Book and Printing Co., Troy, N. Y., 1919. Cloth, 5 x 6½; 169 pages.

The purpose of this work is to place before engineers and others who have had training in chemical analysis, a small practical book on the analysis and manufacture of babbitt metal. The value of a handbook that points out accurate methods of analysis of metals will appeal to those having a desire to duplicate bearing metals that have proved satisfactory in practice. While the bulk of the work is devoted to technical chemical analysis of babbitt metals and the usual ingredients, the notes on the manufacture of babbitt are of especial value to those who have occasion to make mixtures for themselves.

Obituary

Charles Paul De La, of Yonkers, N. Y., a boiler inspector employed by the Employers' Liability Corporation, Ltd., of London, England, and New York City, was suffocated in a boiler at Newburgh, N. Y., Sunday morning, July 27. His body was dragged from the interior of the boiler which he was inspecting, when after an unreasonable length of time he failed to come out. In an unconscious condition he was rushed to St. Luke's Hospital at Newburgh, where he expired. Mr. De La was born in Newark, N. J., and had resided in Yonkers for 25 years. He was well known in this section, where he has been employed by the liability corporation for the last six years, prior to which he was an electrical foreman at the Yonkers branch of the Otis Elevator Company.

Personals

M. S. Sloan, who was operating manager of the New York Edison Co., has been elected president of the Brooklyn Edison Co., succeeding Nicholas F. Brady, resigned.

Fred J. Miller, formerly employment manager for the Remington Typewriter Co., has become associated with H. L. Gantt as a consulting engineer in the Singer Building, New York City.

A. W. Houston has resigned his position as vice president and general manager of the Texas Gas and Electric Co., at Houston, to accept a similar position with the Southern Utilities Co. Mr. Houston will have his headquarters in Palatka, Fla., and will have supervision of plants of the Southern Utilities Co., in Florida and Georgia. He will be succeeded by H. F. Cameron, of the Lake Charles Railway, Light and Power Co.

Lewis S. Maxfield has resigned as assistant to the secretary of the Heating and Piping Contractors National Association to accept a position in the office of the mechanical engineer of the New York Central Railroad.

R. Sanford Riley, president of the Sanford Riley Stoker Co. and the Murphy Iron Works, sailed for Europe on July 26 abroad the "Aquitania." Before his departure he was appointed honorary vice president of the A. S. M. E. He will represent the society and this country at the James Watt Centennial, which is to be held at Birmingham, England. He expects to return about Oct. 1.

Thomas O. Morgan, until recently head of the Service Department of the New York office of the American Steam Conveyor Corp., has been promoted to the position of sales engineer. He will handle Long Island and Connecticut territory.

H. S. Valentine, who has been connected with the Link Belt Co. for the last 5½ years, has been appointed sales engineer in charge of Philadelphia territory for the American Steam Conveyor Corp.

George B. Allan, Texas representative of the Yarnall-Waring Co., Philadelphia, who has been located at 305 Southern Pacific Building, Houston, Tex., will hereafter make his headquarters in Dallas.

Engineering Affairs

The American Association of Engineers, Nickel Plate Section, held a special meeting on July 24 and adopted a constitution and completed the organization of the section. The officers elected are: President, G. H. Trinker; vice president, W. H. Burrage; secretary, Ernest R. Taylor; treasurer, C. R. Wright. Application for a charter will be made to the Cleveland chapter of the association.

The Oregon Society of Engineers unanimously voted at its meeting on July 24 to amalgamate with the American Association of Engineers. Other societies that expect to vote upon amalgamation in the near future are: The Engineers Club of Kansas City; the Engineers and Architects

Association of Southern California; the Southwestern Society of Engineers and the Houston Engineers Club. The question of amalgamation has been initiated by several other societies and is now under consideration by them.

Camden, (N. J.) Association No. 16, N. A. S. E., was instituted on Friday evening, Aug. 1, by State Deputy John J. Reddy, with 28 names on the charter roll. There were delegations from New York, Philadelphia and New Jersey. Mr. Reddy called the meeting to order at 9 o'clock and introduced William J. Reynolds, past national president, who fully outlined the aims and objects or the organization. State President Valentine Secor and State Vice President George Armitage of New Jersey and State Deputy Peter L. Johnson of Pennsylvania also gave interesting addresses. The officers elected included William Hegarty, president; Fred Doudy, vice president; I. R. Stratton, recording secretary; Charles R. Heitz, financial secretary; William R. Johnson, treasurer; William J. Watson, conductor; George W. Wyman, doorkeeper. The board of trustees for one, two and three years, respectively, comprise Wallace Mitchell, Theodore Peterson and Charles Gravenstine. An enjoyable entertainment was furnished by Bob Jones, France Packing Co., and Jack Armour, *Power*. Light refreshments were liberally served.

Miscellaneous News

A new board of examining engineers for Chicago was appointed on July 21. Edward F. Moore was advanced from vice-president to president; Philip M. Gieseler was made first vice-president and Frank A. West, a member of the board.

Business Items

The Graphic Products Co., of Germantown, Philadelphia, has taken over the business heretofore conducted by the Fibre Graphite Manufacturing Co. and will continue to manufacture the latter company's products.

The Tacony Steel Co. and the Tacony Ordnance Corp., of Tacony, Philadelphia, announce the purchase of the Ordnance Corporation plant by the Tacony Steel Co. and the consolidation of the respective metallurgical and manufacturing organizations. The consolidation does not affect the officials or management, as the officers and directors have for sometime acted in the same capacity with the Steel Company and the Ordnance Corporation.

The General Gas and Electric Co. will acquire the Pennsylvania and New England properties formerly owned by the Eastern Power and Light Corporation. This acquisition is a result of plans worked out by the General Gas and Electric Company interests with the various protective committees of the Eastern Power and Light Corporation.

Trade Catalogs

Ross Heater and Manufacturing Co., Inc., Buffalo, N. Y., has just issued 17-page Catalog "C" on "Condensing Equipment with Croll-Reynolds Evactor Air Pump." Fully illustrated; two pages of tables on saturated steam included in booklet.

The Morse Chain Grate Co., Ithica, N. Y., has just issued its Publication No. 14, revised edition, on "Large Power Drives." Morse chain drives are shown as applied to 100 hp. up to 1000 hp.

The Combustion Engineering Corp., New York City, has issued a 20-page catalog, G-1, on "Grieve Grates." It shows in an interesting manner both as to text and cuts the detail operation of this type of grate. A copy may be had free upon request.

The Foxboro Co., Inc., Foxboro, Mass., has just published a finely printed 80-page bulletin, No. 104-1, on "Thermometers." The indicating dial type (regular) and recording instruments are fully described and illustrated, and specimen charts produced by multiple-pen and long distance instruments at different plants are shown. Four pages of conversion tables for Fahrenheit and Centrigrade scales complete the bulletin. A copy may be had free upon request.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons	$2.50@3.00	$2.90@3.60
F. o. b. Philadelphia, gross tons	4.69@5.25	5.10@5.80
F. o. b. New York, gross tons	5.00@5.60	5.40@6.20
Alongside Boston (water coal), gross tons	6.75@7.25	6.95@7.75

Georges Creek is quoted at $3.70 per net ton, f. o. b. mines.

Pocahontas and New River are being quoted at $6 @ 6.25 per gross ton f. o. b. Norfolk and Newport News, Va., in response to export demand. There are practically no sales for coastwise shipment.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5.95	$7.80	Pea	$5.20	$6.95
Egg	6.25	8.10	Buckwheat	3.40	5.15
Stove	6.50	8.35	Rice	2.75	4.50
Chestnut	6.60	8.45	Barley	2.25	4.00

Bituminous

	Spot
South Fork (Best)	$3.10@3.25
Cambria (Best)	2.95@3.10
Cambria (Ordinary)	2.65@2.90
Clearfield (Best)	2.95@3.10
Clearfield (Ordinary)	2.65@2.90
Reynoldsville	2.70@2.90
Quemahoning	3.10@3.25
Somerset (Best)	2.95@3.10
Somerset (Poor)	2.65@2.75
Western Maryland	2.50@2.75
Fairmont	2.10@2.35
Latrobe	2.60@2.65
Greensburg	2.50@2.60
Westmoreland ¾ in.	2.75@2.90
Westmoreland run-of-mine	2.50@2.60

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Anthracite Line	Anthracite Tide		Bituminous Line	Bituminous Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.25	8.10	Rice	2.75	3.65
Stove	6.50	8.35	Boiler	2.50	3.50
Nut	6.60	8.45	Barley	2.25	3.15
Pea	5.20	6.80			

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2.35@2.50	3.00
Screenings	1.40@1.60	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.45	$2.75	$2.40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	....	5.25	.....

Domestic quoations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.95@$4.60
Corona	3.50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County		Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.85*@3.05	$2.55	$2.25@2.50
Mine run	2.10*@2.35	2.35	1.60@1.70
Screenings	1.50*@2.20	2.05	.90@1.00

* Indicates prices on independent coal.

Williamson-Franklin rate to St. Louis is $1.07½; other rates $0.92½.

New Construction

PROPOSED WORK

Mass., Clinton—The Roubaix Mills, 792 Main St., will receive bids about August 15 for the construction of a 4 story steel and reinforced-concrete silk mill. A steam heating system will be installed in same. A. Brociner, 110 West 40th St., New York City, Engr.

Mass., Pittsfield—The South Congregational Church plans to install a new heating plant including boiler house in rear of church. Harding S. Seaver, 7 North St., Arch.

R. I., Providence—The General Fire Extinguisher Co., West Exchange St., will soon award the contract for the construction of a 4 story office building. A steam heating system will be installed in same. Total estimated cost, $150,000. Jackson, Robinson & Adams, Turks Head Bldg., Arch.

N. Y., Arcade—The city has voted $100,000 bonds to build a combined grammar and high school. A steam heating system will be installed in same.

N. Y., Batavia—St. Jerome's Hospital (Sisters of Mercy) will soon receive bids for the construction of a 3 story, 40 x 75 ft. hospital. Low pressure boilers will be installed in same. Total estimated cost, $75,000.

N. Y., Buffalo—The Buffalo General Electric Co. plan to erect a brick transformer station at 385 Abbott Road. Estimated cost, $11,000.

N. Y., Long Island City—J. N. Contade, Jackson Ave. and Bridge Plaza, will soon let the contract for the construction of a 4 and 6 story, 68 x 185 ft. factory. A steam heating system will be installed in same. Total estimated cost, $300,000. Balinger & Perott, 1328 Broadway, New York City, Engr and Arch.

N. Y., Long Island City—Eggleston Bros., c/o A. G. S. Fletcher, Arch., 103 Park Ave., New York City, will soon award the contract for the construction of a 1 story, 200 x 285 ft. warehouse on School St., Borden Ave., and Mount St. A steam heating system will be installed in same.

N. Y., Mineola—The Nassau Hospital is having preliminary plans prepared for altering and building an addition to hospital here. A steam heating system will be installed in same. Total estimated cost, $300,000. Lord & Hewlet, 343 5th Ave., New York City, Arch.

N. Y., New York—The J. M. B. Realty Co., 30 East 42nd St., plans to build a 1 story, 100 x 200 ft. garage on 158th St. near the tracks of the New York Central R.R. A steam heating system will be installed in same. Total estimated cost, $75,000. Gronenberg & Leachtag, 303 5th Ave., Arch.

N. Y., New York—The St. Regis Lunch Co., c/o A. Levinson, Engr., 405 Lexington Ave., will soon award the contract for the construction of a 3 story, 60 x 100 ft. store and loft building at 42 West 33rd St. A steam heating system will be installed in same. Total estimated cost, $80,000.

N. Y., New York—Swift & Co., 32 10th Ave., plans to build a 10 story, refrigerating plant on West 14th St. Estimated cost, $1,000,000.

N. Y., Phoenix—The Sweet Brothers Paper Manufacturing Co. plans to install Sturtevant ventilating fans, upright engine direct connected—set of fan heaters—12 ventilating cowls and steam connections. Estimated cost, between $12,000 and $15,000. E. E. Palmer, Snow Bldg., Syracuse, Engr.

N. Y., Syracuse—The Glenside Mills Co. has purchased the factory building of the Syracuse Rug Works at 11 Tallman St. and plans to install machinery and power transmission. Estimated cost, $15,000.

N. Y., Syracuse—The congregation of St. Anthony of Padua Church, Colvin St. and Midland Ave., will soon receive bids for the construction of a 2 story, 75 x 140 ft. school. A steam heating and fan system for ventilation will be installed in same. Total estimated cost, $85,000. A. R. Acheson, 852 Ostrom Ave., Engr.

N. Y., Syracuse—The United States Hoffman Co. has purchased the Van Wie Pump Co., 709-722 West Fayette St., and will install transmission and machinery tools. Estimated cost, $25,000. J. B. Spencer, Gen. Mgr.

N. Y., Theresa—The Borden Milk Co. will rebuild its plant here, recently destroyed by fire, and will install a new boiler, engine and milk handling equipment. A. Ackerman, Theresa, Local Mgr.

N. Y., Watertown—The Board of Education will receive bids Sept. 1 for installing a heating and ventilating system in school building here, including two 80 h.p. boilers, 10,000 direct radiation—Sturtevant Blower—one set Sturtevant heaters, one 7½ h.p. electric motor, one 48 in. Sturtevant swing ventilating galvanized iron air conveyor. Estimated cost, $17,000. E. E. Palmer, Snow Bldg., Syracuse, Engr.

N. Y., Watertown—The Board of Education will receive bids Sept. 1 for installing a heating and ventilating system in school building here, including two 80 h.p. boilers, 12,000 direct radiation, Sturtevant fan and set heaters, six Sturtevant ventilating cowls, 10 h.p. electric motor galvanized iron air conveyors. Estimated cost, $20,000. E. E. Palmer, Snow Bldg., Syracuse, Engr.

N. J., Westmont—The city received bids for constructing a 9 mile sanitary sewerage system, including a pumping station, etc., from W. Penn Corson, 1141 Sycamore St., Camden, $68,416; R. F. Relly, Easton, Penn., $69,131; Pennsylvania Engineering Construction Co., 1119 North Howard St., Philadelphia, $72,597.

Pa., Erie—The Continental Rubber Co., 119th and Liberty St., will build a 2 story, 78 x 130 ft. power house. Estimated cost, $75,000. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, Ohio, Engr.

Pa., Midland—The Pittsburgh Crucible Steel Co., Empire Bldg., Pittsburgh, is receiving bids for the construction of a 5 story, 50 x 180 ft. office building on Railroad Lane and 7th St. A vapor steam heating system will be installed in same. Fred I. Merrick, Empire Bldg., Pittsburgh, Arch.

Pa., Nanticoke—Nanticoke Borough plans to construct two schools, one 2 story, 25 x 40 ft. and other 2 story, 30 x 50 ft. Steam heating systems will be installed in same. Total estimated cost, $150,000. Austin Reilly, Bennett Bldg., Wilkes-Barre, Arch.

Pa., Oceola Mills—The Oceola Water Co. will receive bids August 15 for the furnishing and erecting steel elevated water tank and installing two 400 gal. capacity pumps. Total estimated cost, $15,000. Morris Knowles, Jones Law Bldg., Pittsburgh, Engr.

Pa., Philadelphia—The Department of Public Health and Charity, Room 584, City Hall, will receive bids August 18 for the completion of power house with mechanical equipment including boilers, engines, and machinery for General hospital. Total estimated cost, $250,000. P. H. Johnson, 1713 Sansome St., Engr.

Pa., Pittsburgh—The Board of Education is receiving bids for the construction of a 3 story, 225 x 250 ft. high school in the Homewood District. Steam heating and ventilating fan systems and low pressure boilers will be installed in same. Total estimated cost, $1,300,000. G. S. Orth & Bro., Jenkins Arcade, Engr.

N. C., Monroe—The city will soon receive bids for the construction of a 2 story brick school on West Lancaster St. A steam heating system will be installed in same. Total estimated cost, $50,000.

S. C., Charleston—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to install 1 turbo-alternator, Specification No. 4011, and mechanical stokers, Specification No. 4010 in the power plant here. Estimated cost, $50,000 and $11,000 respectively.

Ohio, Cleveland—The Allen Theatre Enterprises, Toronto, Ont., is having plans prepared by C. H. Crane and E. G. Kiehler, Arch., 2325 Dime Bank Bldg., Detroit, Mich., for the construction of a 6 story, theatre and office building on Euclid Ave. A complete steam heating system will be installed in same. Total estimated cost, $1,000,000.

Ohio, Cleveland—Barish & Bingham Co., 10601 Madison Ave., plans to build a 2 story, 39 x 123 ft. office addition. A steam heating system will be installed in same. Total estimated cost, $75,000.

Ohio, Cleveland—The Cleveland Worsted Mills Co., 6300 Broadway Ave., will install a steam heating system in the 10 story, 89 x 105 ft. warehouse which it plans to build at 5442 Blanche Ave. Total estimated cost, $400,000.

Ohio, Cleveland—The Colburn Machine Tool Co., 1040 Ivanhoe Rd., will install a steam heating system in the 1 story, 44 x 78 ft. office building which it plans to construct. Total estimated cost, $80,000.

Ohio, Cleveland—Company c/o Citizens Savings & Trust Co., Citizens Bldg., plans to construct a 5 story, 270 x 280 ft. commercial building on East 30th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Cleveland—The Glidden Varnish Co., Madison Ave. and Berea Rd., is having plans prepared for a 4 story, 59 x 90 ft. grinding building on Madison Ave. A steam heating system will be installed in same. Total estimated cost, $60,000. Osborn Engineering Co., 2848 Prospect Ave., Engr.

Ohio, Cleveland—Hoffman Bros., Electric Bldg., will install a steam heating system in the 4 story, 101 x 164 ft. theatre which they plan to build at 10210 Euclid Ave. Total estimated cost, $250,000.

Ohio, Cleveland—Henry O. Oster, 2052 East 105th St., plans to construct a 42 x 280 ft. commercial building addition at East 105th and Euclid Ave. A steam heating system will be installed in same. Total estimated cost. $100,000.

Ohio, Cleveland—A. Teachout Co., 321 Prospect Ave., N. W., plans to construct a 3 story, 100 x 160 ft. lumber mill on West 20th St. and Lorain Ave. A steam heating system will be installed in same. Total estimated cost, $80,000.

Ohio, Cleveland — D. R. Hanna, 511 Leader-News Bldg., plans to construct a 11 story, 100 x 192 ft. theatre on East 14th St. and Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $750,000. C. A. Platt, 101 Park Ave., New York City, Engr.

Ohio, Dayton—The Hollywood Club, 133 West 2nd St., plans to build a 3 story, 60 x 130 ft. clubhouse. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Newark—Bodenstein & Surmann, Arch., 2nd National Bank Bldg., Cincinnati, are receiving bids for the construction of a 2 story, 30 x 60 ft. power house, for W. S. Weldand & Son. Estimated cost, $35,000.

Ohio, South Euclid—Board of Education plans to build a 1 story, 75 x 150 ft. school. A steam heating system will be installed in same. Total estimated cost, $150,000.

Mich., Allegan—The Overton Creamery Co. is having plans prepared by the McCormick Co., Arch. and Engr., Century Bldg., Pittsburgh, Penn., for the construction of a creamery and dairy, including a 40 x 50 ft. power house in which four 150 h.p. boilers will be installed. Total estimated cost, $100,000.

Mich., Detroit—The Allen Theatre Enterprise, c/o F. G. Kiehler, Arch., 2325 Dime Bank Bldg., Detroit, had plans prepared for the construction of a 2 story, 133 x 200 ft. theatre and store building on Woodward Ave. and Watson St. A steam heating plant, fans, vacuum pump motor, etc., will be installed in same. Total estimated cost, $600,000.

Mich., Detroit—The Belle Isle East Side Creamery Co., 1020 Forest Ave., E., plans to build a 2 story, 45 x 100 ft. addition to its creamery. A steam heating system and electric motors will be installed in same. Total estimated cost, $40,000. Williams Bros., 1111 Kresge Bldg., Arch.

Mich., Detroit—C. H. Crane and E. G. Kiehler, Arch., 2325 Dime Bank Bldg., are preparing plans for the construction of a 2 story, 50 x 200 ft. theatre on Michigan Ave. and Chopin St., for Anthony G. Grzezinslki, 1518 Michigan Ave. A steam heating system, fan and motor will be installed in same. Total estimated cost, $50,000.

Mich., Detroit—A. Harvey's Sons Manufacturing Co., First St., plans to build a 2 story, 60 x 100 ft. foundry on Bellevue Ave. and Michigan Central Ry. A steam heating system will be installed in same. Smith, Hinchman & Grylls, Washington Arcade, Arch.

Mich., Detroit—The Ionic Lodge F. & A. M., Lawton and Grand River Ave., is having plans prepared for the construction of a 3 story, 90 x 100 ft. temple on Grand River Ave. A steam heating and ventilating system will be installed in same. Total estimated cost, $130,000. G. W. Graves, 43 John River St., Arch.

Mich., Detroit—The Moore Realty Co., 512 Holden Bldg., plans to construct a 2 story, 75 x 100 ft. mercantile building on Grand River Ave. near Vinewood St. A steam heating system will be installed in same. Total estimated cost, $100,000. R. Arthur Bailey, 54 Lafayette Ave., Arch.

Mich., Detroit—B. C. Wetzel & Co., Arch., 2317 Dime Bank Bldg., is preparing plans for the construction of a 2 story, 95 x 200 ft. commercial building and hall on Woodward Ave. and Watson St. Steam heating equipment including a boiler, vacuum pump and accessories will be installed in same. Total estimated cost, $150,000. Owner's name withheld.

Mich., Detroit—Zemon & Wetsman, 1020 Chamber of Commerce, plans to build a 2 story theatre, bank and store building on Linwood Ave. and Virginia Park. A steam heating system will be installed in same. Total estimated cost, $150,000. G. V. Pottle, 1401 David Whitney Bldg., Arch.

Mich., Ecorse—St. Francis Parish plans to build a 2 story, 80 x 150 ft. school on State and Webster St., and will install a steam heating system; also boiler, vacuum pump and motor and fans for ventilation. Total estimated cost, $150,000. G. W. Graves, 43 John R. St., Detroit, Arch.

Mich., Holly—Holly Lodge F. & A. M. is having plans prepared for the construction of a 3 story, 63 x 108 ft. temple on Main St. Steam heating equipment, including a boiler and pump will be installed in same. Total estimated cost, $100,000. G. W. Graves, 43 John R. St., Detroit, Arch.

Mich., Houghton—The Good Will Farm will soon award the contract for the construction of a 2 story, 83 x 134 ft. home. A steam heating system will be installed in same. Total estimated cost, $100,000. Maas Bros., 400 Penobscot Bldg., Detroit, Arch.

Mich., Marysville—Wills & Lee, Book Bldg., Detroit, are having plans prepared by Smith, Hinchman & Grylls, Arch., 710 Washington Arcade, Detroit, for the construction of an automobile factory along the St. Clair river. A power plant will be part of the proposed construction.

Mich., Negaunee—St. Paul's Parish house will soon award the contract for the construction of a church, school and parish house. A steam heating system will be installed in same. Total estimated cost, $150,000. Van Leyen, Schilling & Keough, 1115 Union Trust Bldg., Detroit, Arch.

Ill., Bellville—The St. Clair National Bank Co., c/o William Reichert, Freeburg, plans to build a bank here. A steam heating system will be installed in same. Total estimated cost, $150,000.

Ill., Chicago—Holabird & Roche, Arch., 104 South Michigan Ave., are receiving bids for the construction of a 19 story, 85 x 190 ft. hotel, at 177 West Madison Ave., for the Blackhawk Hotel Co., c/o architects. A steam heating system will be installed insame. Total estimated cost, $1,250,000.

Ill., Chicago—The Madison & Ketzie Bank, 3131 Madison St., plans to construct a 2 story, 100 x 120 ft. bank on Madison & Ketzie Ave. A steam heating system will be installed in same. Total estimated cost, $325,000. J. K. Cady, 179 West Washington St., Arch.

Ill., Chicago—W. G. Shedd, c/o A. S. Alachuler, Arch., 28 East Jackson St., will soon receive bids for the construction of a 12 story, 75 x 125 ft. office building on Wabash and Harrison Ave. A steam heating system will be installed in same. Total estimated cost, $1,300,000.

Wis., Bloomington—The Board of Education c/o City Clerk, will install a steam heating or hot water heating system in the 4 story, 90 x 150 ft. high school which it plans to build on Main St. Total estimated cost, $75,000.

Wis., Hartford—The city will receive bids Aug. 15 for furnishing 2 new boilers of 400 h.p. each and 3 boilers of 250 h.p. each. Estimated cost, $15,000. W. Rodke, City Clk.

Wis., Neenah—The First National Bank is having plans prepared for a 1 story, 41 x 84 ft. bank. A steam heating system will be installed in same. Total estimated cost, $100,000. Childs & Smith, 64 Van Buren St., Chicago, Arch.

Wis., Two Rivers—The Hamilton Manufacturing Co. will soon award the contract for the installation of an electric fire pump, service pump and bilge pump in power house here. Total estimated cost, $20,000. Lock & Green Co., Chicago, Engr.

Kan., Fort Dodge—The State will soon award the contract for the construction of a 2 story, 67 x 166 ft. Soldiers' Home. A steam heating system will be installed in same. Total estimated cost, $75,000. R. S. Gamble, Topeka, State Arch.

Kan., Marion—Marion County is having plans prepared by Tonini & Bramblet, 417 Terminal Bldg., Oklahoma, Okla., for the construction of a 3 story, 96 x 124 ft. courthouse. A steam heating system will be installed in same. Total estimated cost, $300,000.

Mont., Helena—The Algeria Patrol Shrine will soon receive bids for the construction of a 1 story temple, which it plans to build on Neil and Benton Ave. A steam heating system will be installed. Total estimated cost, $200,000. S. S. Haire and C. H. Carsley, Power Bldg., Arch.

Mont., Scobey—The city will soon award the contract for improving the waterworks, including the installation of a 300 gal. per minute and a 150 gal. per minute centrifugal pump and 40 h.p. semi Diesel engine. Total estimated cost, $85,000. W. B. Saunders, Helena, Engr.

Mo., Cameron—The city will soon award the contract for the construction of a 160,000 gal. filtration plant and will install motor-driven centrifugal pump, etc. E. E. Harper, 2408 East 30th St., Kansas City, Engr.

Mo., Carthage—The Platt-Porter Wholesale Grocery Co. is having plans prepared by Perry K. Simpson, Arch., Carthage, for the construction of a 2 story, 50 x 160 ft. wholesale grocery house on 6th and Main St. A steam heating system will be installed in same. Total estimated cost, $55,000.

Wash., Aberdeen—The Pantages Amusement Co. plans to construct a 4 story theatre and office building on I and Wishah St. A steam heating system will be installed in same. Total estimated cost, $175,000.

Ore., Astoria—Jensen & Von Herberg, Portland, owners of the Columbia and Liberty theatres, have purchased a site here and plans to build a 3 story, 100 x 166 ft. theatre. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ore., Pendleton—School District No. 117, R. F. D., No. 1, plans to install 700 gal. per hour pumping and vapor heating system. Estimated cost, $5000. G R. Wright, 614 Main St., Arch.

Cal., Chico—The City Trustees have directed F. S. Robinson, City Engr., to make a preliminary survey and submit estimate for power plant in Chico Creek to develop 3000 h.p.

Cal., Copperopolis—The Calaveras Copper Co. is having plans prepared for the construction of a reservoir and power plant.

Cal., Los Angeles—The Albertson Motor Car Co. is having plans prepared for the construction of a 2 story, 155 x 160 ft. auto sales building on 16th and Figueroa St. A steam heating system will be installed in same. L. A. Smith, 621 Investment Bldg., Arch.

Ont., London—Marcus Loew, 1492 Broadway, New York City, will receive bids until Aug. 11, for the construction of a 1 story, 100 x 125 ft. brick and steel theatre. A steam heating system will be installed in same. Total estimated cost, $200,000. T. W. Lamb, 644 8th Ave., New York City, Arch.

Ont., Ottawa—Allen W. Horwood, Arch., Castle Bldg., Queen St., is receiving bids for the construction of a 3 story, 60 x 100 ft. store building on George St., for A. J. Freiman, Rideau St. A steam heating system will be installed in same. Total estimated cost, $80,000.

Ont., Ottawa—Loew's Theatre, 1492 Broadway, New York City, will soon award the contract for the construction of a 2 story, 100 x 175 ft. theatre. A steam heating system will be installed in same. Total estimated cost, $300,000. T. W. Lamb, 644 8th Ave., New York City, Arch.

Ont., Strathroy—Dominion Canners, Aylmer, will soon award the contract for the construction of a canning factory, here, to include a process room, boiler, engine house and storage building. Total estimated cost, $75,000. T. Wooster, Aylmer, Arch.

Ont., Thorold—The Ontario Paper Co. will purchase transmission and drive machinery to replace same damaged in recent fire. Estimated cost, $5000.

Sask., Moose Jaw—The city plans to install a Diesel engine and pump in connection with proposed waterworks system. Estimated cost, $148,000.

CONTRACT AWARDED

Mass., Boston—The Upson Paper Co., Upson Point, Lockport, N. Y., has awarded the contract for the construction of a new mill, to the Aberthaw Construction Co., 27 School St. Plans include an engine and boiler room, etc. Total estimated cost, between $250,000 and $300,000.

R. I., Crompton—The Crompton Co. has awarded the contract for the construction of a 2 story, 110 x 200 ft. addition to its mill, to J. F. McCusher, Phenix. A steam heating system will be installed in same. Total estimated cost, $125,000.

R. I., Pawtucket—J. W. Little Co., Exchange St., has awarded the contract for the construction of a 2 story printing plant to F. G. Rowley Co., 260 Central Ave. A steam heating system will be installed in same. Total estimated cost, $40,000.

N. Y., Binghamton—The Kodeco Co. here awarded the contract for the construction of a 62 x 133 ft. reinforced concrete and brick theatre at 29 Chinango St., to A. E. Badgley, Binghamton. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. Y. Black River—The Northern New York Utilities Co., 58 Public Sq., Watertown, has awarded the contract for the construction of a power dam and 2450 ft. power canal to Burns Brothers & Haley, Watertown; construction of a reinforced concrete power house for installation of three 000 h.p. generating units, to the Walsh Construction Co., Davenport, Iowa. Total estimated cost, $600,000. Electric equipment will be furnished by the General Electric Co., River Rd., Schenectady, and hydraulic equipment by S. Morgan Smith Co., York, Pa. Noted June 24.

N. J., Jersey City—The Board of Education has let contract for installing exhaust fan and electrical equipment in the Lincoln High School, to Walter Coleman, Willow Court. Estimated cost, $10,000.

Penn., Philadelphia—The Vigogne Mills, Adams Ave. and Wingohocking St., has awarded the contract for the construction of a 3 story, 63 x 250 ft. factory on Unity and Oakland St., to M. Ward Easly, 1420 Chestnut St. Bids will soon be received for a steam heating system in same. Total estimated cost, $100,000. Noted July 15.

Ohio, Cleveland—J. M. & L. A. Osborn Co., Superior Viaduct, has awarded the contract for the construction of a 2 story, 130 x 150 ft. warehouse on East 39th St. and Superior Ave., to Sam W. Emerson Co., 1900 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $300,000. Noted April 15.

Ohio, Euclid—The Cleveland Heights Board of Education has awarded the contract for the construction of a 2 story, 75 x 100 ft. high school in Euclid Village, to Kelley Demarest Construction Co., American Trust Bldg., Cleveland. A steam heating system will be installed in same. Total estimated cost, $100,000. Noted July 8.

Ohio, Lorain—T. C. Metzer, Broadway Ave., has awarded the contract for the construction of a 5 story, 70 x 140 ft. hotel, to Crowell Lundoff Little Co., Meriam Bldg., Cleveland. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Middletown—The American Rolling Mills Co. has awarded the contract for the construction of an extension to its sheet and jobbing mill plant, to Westinghouse Church, Kerr & Co., 37 Wall St., New York City. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

Mich., Detroit—The Commerce Motor Car Co., Solvay and Mackie Ave., has awarded the contract for the construction of a 1 story, 120 x 240 ft. auto truck factory, to L. W. Zander, 708 14th St. A steam heating system and electric motors will be installed in same.

Mich., Detroit—Myles Standish, 39 Pingree Ave., has awarded the contract for the construction of a 3 story, 60 x 150 ft. garage on Woodward and Hancock Ave., to John Finn & Son, 2375 Woodward Ave. A steam heating system will be installed in same. Total estimated cost, $65,000.

Mich., Redford—St. Mary's Parish has awarded the contract for the construction of a 2 story, 80 x 160 ft. school, to John Finn & Son, 2375 Woodward Ave, Detroit. A steam heating system will be installed in same. Total esimated cost, $150,000.

Ill., Chicago—Albert Pick & Co., 212 West Randolph St., has awarded the contract for the construction of a 5 story warehouse on 35th St. and Racine Ave., to E. W. Sproul Co., 2001 West 39th St. A steam heating system will be installed in same. Total estimated cost, $400,000.

Ill., Chicago—The Cleveland Metal Products Co., Platt Ave., Cleveland, has awarded the contract for the construction of a 3 story, 90 x 200 ft. warehouse on West 43rd St. and Western Ave., to the Austin Co., 208 South La Salle St. A steam heating system will be installed in same. Total estimated cost, $150,000.

Ill., Chicago—The Commonwealth Edison Co., 72 West Adams St., has awarded the contract to the Black Construction Co., 20 West Jackson St., for the construction of two 2 story, 40 x 84 ft. concrete and brick transformer stations, one at 6909 Throop St. and other at 2644 Irving Park Blvd., each to contain 3 transformers of 4000 k.w. capacity. Total estimated cost, $175,000.

Ill., Chicago—St. Philip Benici Catholic congregation, Oak and Cambridge St., has awarded the contract for the construction of a 2 story, 60 x 105 ft. school, to F. Burke, 35 South Dearborn St. A steam heating system will be installed in same. Total estimated cost, $75,000.

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